AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Executive Office of the Society: Saint Joseph, Michigan.

SAMUEL P. LYLE, *President* RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 19 AUGUST 1938 NUMBER 8

CONTENTS

EDITORIALS 341

BRIDGING THE GAPS 343
By Leonard J. Fletcher

FORCED VENTILATION OF BROODERS 348
By Larry Moore

DEHYDRATION OF FRUITS 349
By E. M. Mrak

EQUIPMENT FOR PLANT DISEASE CONTROL 353
By V. H. Matthews

USE OF MODELS FOR STRUCTURAL DESIGN 355
By James R. Griffith

SOME OBSERVATIONS ON THE BEHAVIOR OF MODELS OF GULLY CONTROL STRUCTURES 359
By H. B. Roe

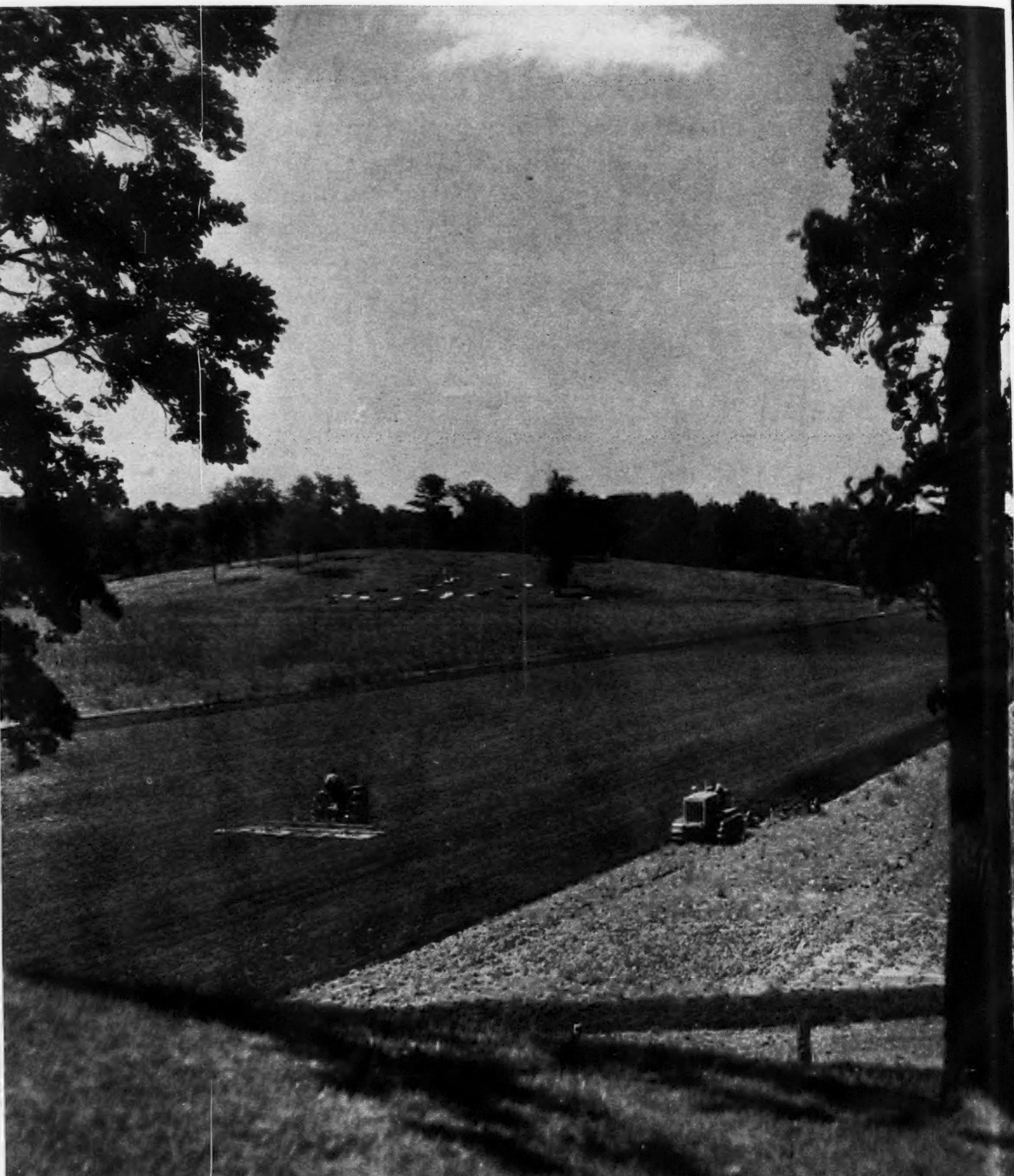
OUTDOOR BROODING OF CHICKS 363
By A. R. Wood

WHAT AGRICULTURAL ENGINEERS ARE DOING 365

NEWS 367

AGRICULTURAL ENGINEERING DIGEST 372

Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the executive office of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .



Two-Tractor Economy

TOURING a farm on two or more tractors may be profitable for the farmer when his range and scale of operations, the fertility of his soil, generally good farming practices, conservation considerations, importance of timeliness, satisfactory markets, peak operating loads, tool maneuverability and control requirements, and possible fuel and labor economy combine to enable the additional one or more tractors to increase farm income more than they increase operating overhead. Heavy and light tractors on the same farm provide a wide range of flexibility and adaptability to daily changes in power requirements. The use economy of farm power sources and operated equipment is a matter of agricultural-engineering production economics.

AGRICULTURAL ENGINEERING

VOL 19, NO 8 EDITORIALS AUGUST 1938

Research in Research

A CERTAIN darktown cabaret, in its attempt to achieve the ultra-ultra atmosphere, is named "The Research Pleasure Club." Its researches into the complex science of pleasure sometimes lead to additional research by the police as to the legal status of its activities.

Research in agricultural engineering has similarly been made the object of investigation, not as to its legality but as to its standards of performance, by the A.S.A.E. Committee on Research.

In effect, the Committee is anxious that agricultural engineers shall do far more than simply borrow the ivy-covered dignity of the word. Whatever research might mean to special groups with unique purposes, as an agricultural engineering activity supported by public funds it might well have its meaning clearly defined, and widely understood by agricultural engineers themselves, their administrators, and the supporting public.

Apparently no dancing-girl research lightened the labors of the Committee when it convened during the annual meeting of the A.S.A.E. at Asilomar. The report of its deliberations indicates a serious and somewhat controversial session.

A contribution from E. A. Silver, chairman of the Committee, appealed for more fundamental research, a deeper prying into the intimate details of cause and effect.

H. B. Roe defined fundamental research as "the efforts to discover and state those laws of physics and chemistry which have to do with the problems in hand." Dr. F. A. Brooks raised a question as to time and money limitations, and gave an illustration of a short practical investigation giving an early answer to a practical problem, where fundamental research was out of the question. R. L. Perry suggested that even a low-cost attempt to obtain a quick answer to a specific question, if conceived, planned, and carried out so that the result is correct for the conditions encountered, is a good piece of work. He also indicated that to report a practical investigation in generalized terms would be a step toward more fundamental work.

C. A. Bennett stated, "In our research work at the (U.S.D.A.) cotton ginning laboratories, we regard fundamental research as being the exploration of or quest for those basic laws which underlie the phenomena of our problems." He added that, in his opinion, "public institutions are the proper sources for information resulting from fundamental or basic research."

"In our experience," S. H. McCrory said, "this matter of research has been more dependent upon suitable leaders and personnel, than upon funds and equipment."

Acting Chairman Arthur W. Turner indicated that the Committee might contribute to improved quality and reduced duplication of research by further study of three phases, namely, (1) research which arrives at problems, (2) experimentation or following different modes of attack in solving the problems, and (3) applying results through machinery, methods, or other forms of usefulness.

Ben D. Moses contributed a paper emphasizing the importance of agricultural engineers in the colleges cooperating wholeheartedly with scientists in the various other departments in the solution of agricultural problems.

"What Industry Expects of Public Service Institutions Working in Research," a contribution by H. W. Gerlach, emphasized industry's desire that agricultural engineers in public service develop "better use of already existing agricultural machines and study operations now done by laborious or inefficient processes that might be improved upon by modification of old or by development of new mechanization." In discussing this paper, Col. O. B. Zimmerman leaned toward the fundamental approach, even for certain industrial research, and illustrated his point by the improved performance and material saving resulting from a thorough technical research on agricultural wheels. H. P. Smith supported, from the viewpoint of an engineer in public service, the appeal for cooperation between engineers in industry and those in public service, especially with regard to manufacturers utilizing and making commercially available the improvements developed in the course of publicly supported research work.

Several others participated in the discussion, but we do not have a report of their contributions.

Choice of problems, status of related basic information, demand for early practical results, personnel, leadership, limitation of time and funds, duplication, and cooperation of agricultural engineers with industry and science are all factors influencing the quantity, quality, character, and ultimate value of research undertaken by agricultural engineers. It seems unlikely that the Committee will arrive at any simple, easily applied formula for determining in advance the most fruitful procedure under any particular circumstances. It will be a big help, however, if they can arrive at and promote a more definite understanding of what agricultural engineering research is or involves, and of principles influencing the yield and value of results.

Periodicals and Engineering Progress

DR. HARRISON W. Craver, director of the Engineering Societies Library, is authority for the statement that technical periodicals are the leading literary contribution to engineering progress.[1] "It is in the periodical," he says, "that one looks to find the details of new discoveries and innovations, fresh from the discoverer's mind and in his own words. Here too are found those things of new fields, suggestions of unexplored paths, that are the inspiration of further investigations."

This, incidentally, defines clearly the purpose and usefulness of AGRICULTURAL ENGINEERING in its field. It is a point to be kept in mind by readers and contributors.

[1] "The Role of the Library in Engineering Education and Research," by Dr. Harrison W. Craver. "Civil Engineering," July 1938.

The Coordinating Function of Agricultural Engineers

MOST AGRICULTURAL engineers, as this branch of the engineering profession grows, will not design or manufacture farm equipment, but will aid manufacturers with an intimate knowledge of farm-use requirements.

Neither will they farm, but they will help farmers select and utilize improved equipment to suit specific individual farm requirements.

Nor will many of them undertake highly technical researches in pure or applied science, but they will indicate to scientists and research engineers knowledge and equipment needed by farmers and manufacturers; and they will suggest farm and manufacturing applications of knowledge produced by research.

Such, briefly, is the picture of agricultural engineers as coordinators painted by Leonard J. Fletcher in his address published in this issue. It implies an intimate working knowledge of farming and of engineering, and at least a speaking acquaintance with several branches of science. It does not impute to agricultural engineers any intrinsic superiority in mechanical, structural, electrical, civil, chemical, or other technique of engineering.

Furthermore, there is nothing to keep an engineer from jumping the special field of his training and being successful in some related work. It is often done. Verbal fences set up by professional authorities are not intended to limit the usefulness of individuals, but to outline boundaries as a matter of information. Mr. Fletcher's picture applies not to individual capacities but to a group opportunity. As such it gives information and expresses a viewpoint worthy of thorough consideration by the colleges and industries training and using agricultural engineers, by agricultural engineering students and recent graduates, and by students or engineers from other branches of the profession to whom the grass may look greener on the agricultural-engineering side of the fence.

From Mr. Fletcher's viewpoint, which is widely supported by others, agricultural engineers as a group, meaning most but not all of its individual members, will find little opportunity to solve important problems entirely by themselves, or to demonstrate any superiority in the strictly technical fields of the older branches of engineering. However, they are, or should be, ideally suited by training and background to coordinate the individual work and experience of farmers, scientists, manufacturers, and other engineers for the progress of farming as a way of living and of earning a living. Careful consideration needs to be given to individual characteristics and capacities before any engineer jumps, or is pushed, into or away from this major agricultural engineering group opportunity.

Advertising Labor Content for Goodwill

ARNOLD P. YERKES, during the first public forum sponsored by American Engineering Council and held at Philadelphia (May 13), made an important contribution to the discussion which has not yet been adequately reported to agricultural engineers. It came to our attention in the recently published report of the forum.

"It seems to be generally admitted," said Mr. Yerkes, "that machines have not been responsible for the unemployment for which they are so frequently blamed, and yet the average man on the street, or the 'majority voter' . . . . grabs that idea when it is presented, and it is continually presented to him."

As a means of spreading the correct information, Mr. Yerkes proposed that it be brought to the attention of national advertisers that it might be to their interest to advertise the hours of labor represented in their products. He called attention to figures showing, for example, that the automobile of today represents 25 per cent more labor or man-hours than the automobile of 1913.

He also cited one of the strongest proofs that labor-saving equipment makes more and better new jobs than it destroys, instead of decreasing the demand for labor. This proof is the information, made available by the Manufacturers and Allied Products Institute, that "the United States for the past 75 years has used more labor-saving equipment than all the rest of the world put together, and during the last 50 years, instead of having people unemployed, as a rule, and looking for jobs in the countries where they were using hand labor, we brought in and put to work 25 million people, and kept them working at pretty good jobs, except during the depression years."

Facts like these bear repeating. Mr. Yerkes has pointed out, we believe, a way in which national advertisers of consumer goods or services in qualities and at prices made possible only by labor-saving equipment, can build goodwill for their products by promoting public understanding of simple engineering-economic facts. The goodwill resulting might easily be reflected in increased sales, in reduced labor trouble, in reduced legislative interference, and in increased employment.

The idea could easily and quickly be put in effect, at no increased advertising cost. We would like to see more support for thorough study and fair trial of what sounds like an exceptionally good way of solving an important industrial and engineering public relations problem.

Engineering Specialization

AS THE science base of the whole engineering profession broadens and becomes more complex, and the applications of engineering more diversified, more specialization is inevitable. It is the normal expression of individuals and groups recognizing their interests and capacities, and seeking the degree of division of labor at which they may function with highest professional efficiency. It is believed engineers generally will agree to this.

This is a development which the organized engineering profession may well guard and guide, to see that its technical and professional standards are maintained, but which it need not fear, and should not hinder.

Bridging the Gaps

By Leonard J. Fletcher

EVERYONE in the agricultural engineering profession has some direct or indirect interest in that part of industry serving agriculture or utilizing agricultural products. Anything affecting the welfare of this section of industry should rightfully be of real concern to agricultural engineers. And viewed from another angle that section of industry as represented by manufacturers of farm equipment, fencing, farm building materials, and the like, has a real interest in the agricultural engineer; his college training, his post-college development, and the final product; the man who is the experienced and valuable contributor to the solution of many problems of design, distribution, and utilization.

It is interesting to note in a study made in June 1937 that of 730 agricultural engineering graduates from eight institutions, 97, or 13 per cent, were employed in the farm equipment industry. A further breakdown from the institution supplying the greatest number of graduates indicates that about one-half of these men are now engaged in design or engineering activities, and half in sales and advertising.

While this may not be a very large per cent of the agricultural engineering graduates of the past, the farm equipment industry is capable of absorbing a large number of agricultural engineering graduates once the avenues of utilization for such men are established. It is only natural, in the early years of a growing profession, that many of its members should be engaged in propagation, or teaching. Of these 730 graduates, just mentioned, 208, or 28 per cent, are engaged in agricultural engineering teaching or research.

If a farm machine could be said to have a life cycle, it undoubtedly would go through four main stages—(1) design and field trial, (2) production, (3) distribution or selling, and (4) use. These four phases of the "career" of a machine do not weld naturally one into the other. Agricultural engineers have a most definite contribution to make in this matter of connecting these four stages. We must help bridge the gaps.

Before discussing in detail these four fields of use, I wish to point out that as a profession agricultural engineering must be cooperative and by and large the individual agricultural engineer finds that his best contribution usually will be made while cooperating with someone else toward the solution of a common problem. In general, he interprets the broad and varied fields of engineering knowledge for the industry of agriculture.

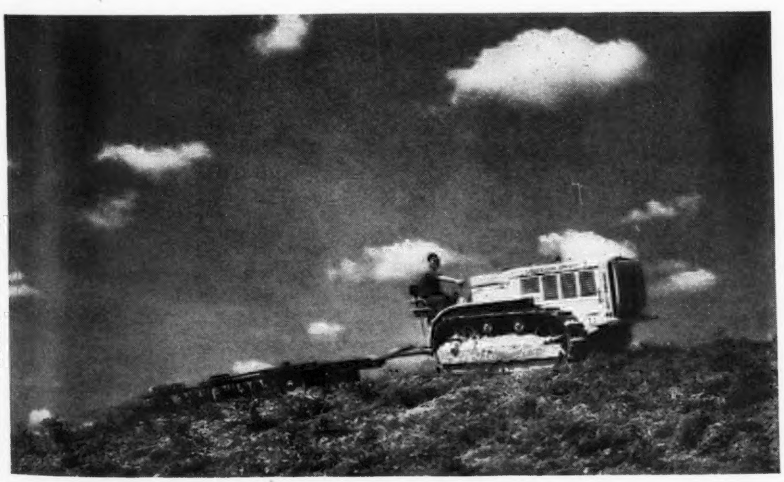
It is thus evident that the agricultural engineer is not the only one to make a technical contribution in this bridging of the gaps. It is my opinion, moreover, that his services will lie more largely in *connecting* these four fields or stages than directly within the fields of design of machines, factory production, the details of sales, advertising, and credit administration, or the actual use of the machines themselves. He is likely, as time goes on, to be found more largely within the fields of selling and utilization than within the field of design and production.

Design — Production. Let us study more in detail these gaps. That one lying between design and production involves the field testing of pilot models as well as production units. The agricultural engineer brings to this activity his knowledge of soils and crops, his ability to measure the economic return of the machine, as well as the knowledge which allows him to represent adequately the viewpoint of the farm owner as he may later judge the machine. Machine designers without a good knowledge of agricultural conditions will often entirely overlook important items of design. After these pilot model machines have been approved and go into production, it is costly and difficult to make even minor changes. Thus the agricultural engineer has a place on the proving ground and in the testing activities of those manufacturers whose machines or materials are used by farmers.

Production — Selling. After production, every manufacturer has the problem of sales. Selling is considered by

An address before the annual meeting of the American Society of Agricultural Engineers at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Assistant general sales manager, Caterpillar Tractor Co. Fellow A.S.A.E.



One of the gaps to be filled in the farm equipment business is between the buyer and the seller, who both need to contribute something in order that the right machine may be properly put to work on the right job. The buyer can contribute information on job requirements, and the seller, if represented by an agricultural engineer, can contribute knowledge of machine characteristics, capacities, hookups, and the experience of farmers in handling similar jobs

some as a necessary evil or nuisance which must be endured in the process of transferring goods from the factory to the user. That this is so is evidenced by the great amount of interest in all manner of schemes for eliminating the middle man. Consumer cooperatives, direct buying, and the like are examples.

In the field of selling, the agricultural engineer can make a great contribution. There is opportunity for absorbing many more men of the profession, in distribution than there is in the manufacturing activities. One well-trained man can render most effective service during the time that a machine is under development, but many trained men are required to assist this machine to render profitable use under the variable conditions encountered in world agriculture. Up to the time the machine leaves the production line, it is a combination of mechanical shapes and devices. Once it leaves the line it is a potential producer of wealth but entirely helpless to find for itself where and how it can best serve. Thus in preparing the machine for efficient selling the agricultural engineer can assist materially in determining the field of use of individual models of machines. He can determine the sound reasons why the machine should be employed. He can assist in the advertising program, making sure that a machine is described and pictured so as to bring out in an understandable way its important characteristics. He can collect and prepare accurate operating data.

Selling — Use. There is considerable evidence that a fundamental change is slowly taking place in the relation between the seller and the buyer, not only of agricultural machinery but of many manufactured products. The human race changes slowly in its basic characteristics. We all have in us a deep-seated desire to bargain, which undoubtedly goes back to the days of barter, when we exchanged directly the products of our work. This is evidenced by the fact that the automobile industry today is wondering whether they are in the business of manufacturing and selling new machines, or in the business of buying used machines. Perhaps the buyer is becoming the seller and the seller the buyer. No thinking person, however, can study the distribution of wealth-producing machines such as agricultural equipment, without coming to realize that the proper kind of selling is a real service to the buyer, and worth all that it costs.

When a farmer purchases a new piece of equipment, he must make a decision which will materially affect the conduct of his business and the profits to be derived therefrom. He should welcome the assistance of anyone qualified to help him make the right decision as it applies to his own individual farming enterprise. No two farms are alike. Each presents a somewhat different set of requirements. The selling transaction, however, often is considered or spoken of in terms of a "battle". The term "overcoming selling resistance" is a common one. There is no more reason why the relationship between a qualified seller of farm equipment and a qualified buyer of farm equipment need to be antagonistic, than the relationship between a doctor and his patient, or a teacher and his pupil.

There is evidence that this "before sales" relationship is bringing forth more effort on the part of the buyer to study carefully his situation and be able to present to the seller more reliable data on which a qualified sales representative may base sound recommendations. If every farmer realized that in the long run, when he buys equipment from an established concern, he pays for every call of every salesman, he would likely be more cooperative and be more concerned about conserving the time of these men when they call.

Special equipment combinations and modifications for special needs, based on agricultural engineering job analysis. Here hops are being cultivated and top-twined in one operation at 4 mph, covering 12 to 15 acres per day

On the other hand, if selling is to be a service, and buyers are going to be considerate of the salesman's time, then the seller, through training and experience, must be able to contribute something to the farmer for the time he devotes to any sales interview. Here the agricultural engineer is eminently qualified to discuss more effective utilization of machines, possible adaptation of new machines or attachments, ways of improving the service rendered by machines already owned, and the like.

Right here let me emphasize the opportunity afforded many agricultural engineers to engage in the retail implement business. Here is a field of activity that pays well the qualified dealer who combines a thorough knowledge of farm machinery, business ability, and the desire to work. The man who is working for himself is seldom unemployed. The farmer is a relatively constant consumer of goods and services.

Perhaps of even greater importance in this new seller-buyer relationship is that which takes place after a sale is made. In the old "battle" method the buyer had to beware before purchasing, which resulted in his leaving all the work to the seller, while after the sale was made the buyer could sink or swim, depending upon his ability to get along without assistance. Largely because the manufacturer has learned that a satisfied owner is his most valuable sales asset, more and more attention is being given to contacts with the buyer after he has taken possession of the new machine. Qualified men call to make sure that the new owner understands the care, adjustment, and operation of the machine. Other calls are made to see how the machine is operating after periods of time have elapsed. Many companies supply cost record books. All companies provide service manuals intended to give in a clear manner instructions as to care and operation of the machine. In all of these after-sales activities the agricultural engineer is qualified to make a real contribution.

Use — Production. The life cycle of the machine is completed when the engineering department of the factory is made acquainted with the performance of the machines

they have built or with the field requirements of new machines to be built. Here is a fertile field for the agricultural engineer. He must call upon his ability to analyze real efficient operation. It is difficult to determine whether the ultimate has been reached in any mechanized process. Assuming that the ultimate will never be reached, then it is necessary to determine the economic limit beyond which at the time it is impracticable to go. The agricultural engineer must determine the probable increased cost in investment or operating expenses against the improved service which might be rendered, if some existing farm operation is further mechanized. He must be able to secure operating data, draw up requirements for new equipment and present his ideas and facts in a way that will be understood and accepted by engineers charged with the designing of new equipment. (Let me in confidence tell you this is not an easy job.)

It is difficult to work in the field, to study the products of your company, to think of new and improved methods, and yet carry on in such a manner as not to disturb the sale of existing machines or impart to users your ideas of possible improvements in the machines he has purchased. It is evident that we would yet be producing our crops by hand if the farmers of the world waited to use the machines which *might* be produced tomorrow rather than those which *are* available today.

Thus we have four gaps to fill:

1 Between design and production where new ideas are tested and better adapted to the farm requirements
2 Between production and sales where the service of the machine is defined and fields of use established
3 Between the seller and the buyer where the right machines are properly put to work on the right jobs
4 Between the user and the factory designer where improved or new mechanization is conceived and given definite shape.

* * *

PREPARATION OF COLLEGE MEN FOR INDUSTRY

Those responsible for the training of agricultural engineers might like to know what industry requires of the agricultural-engineering graduate. We have heard much about curricula. I wish to call your attention to the fact that industry does not hire curricula—neither does industry hire the "Ph.D. power" of the faculty. Industry does hire the product of the university, selected individually. Trained specialists from industry visit educational institutions, interview graduating students, and offer positions to those whom they feel have the necessary qualifications. Colleges set the prerequisites for entrance to their various courses; industry sets its prerequisites for entrance to what usually proves to be the life-long course of the applicant.

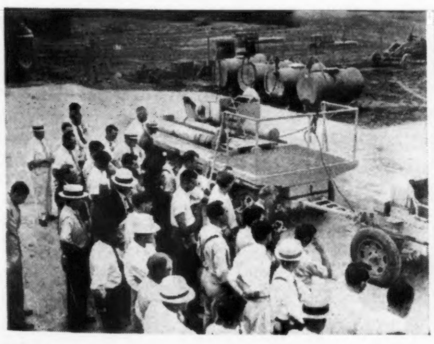
What does industry want in the college-trained recruit? College instruction should be considered as training for a start rather than a finishing process. Industry is one of the principal customers for the products of the university. The successful producer knows well and caters to the demands of his customers. Industry is looking for those qualities and characteristics in the graduating student which will allow him to get along with others, which indicate his desire to continue to learn, which show initiative, tolerance, and patience, combined with a proper degree of aggressiveness.

The following excerpt taken from the "The Engineering Graduates' First Years in Industry" by F. L. Eidmann, Columbia University, contains about the same comments as secured by many other similar investigators:

> How about the young engineers who do not prove satisfactory? What is wrong with them? The answers indicate almost unanimously that personal traits and attitude rather than lack of technical training or ability are responsible. The principal fault seems to be the "inability to get along with their associates", or the "lack of ability to fit in quickly with their fellow employees and to make friends readily". The criticism mentioned in the next largest number of replies is "overeagerness for advancement". Other criticisms are: "Unwillingness to prepare for advancement over a long enough period", "lack of aptitude for engineering work", "inability to adapt themselves to the routine of operating work and at the same time avoid getting into a rut", "lack of initiative", "inability to grasp the practical aspects of problems and situations", "impractical and unable to apply themselves", and "lack of willingness to work".

May I suggest that the college accept a greater responsibility for training in those characteristics and abilities which industry demands. Colleges should grade on more than just the "right answer". Every instructor should be asked to carry this responsibility for training in attitude, correctness and clearness in speech and written expression, and all those other characteristics which mean so much in the success of men who must work with other men.

Perhaps a dual grading system might be established—one on subject matter and one on these other characteristics which might be called the x qualities. Each instructor should show the progress made by each of his students in his x characteristics. The development of the student in these qualities would be a test of both the teacher and the student. The faculty advisory system is not sufficient. Some advisors are not qualified—others seriously overloaded. It is quite possible that certain faculty members themselves



(Left) New men in the tractor industry studying a tractor dynamometer test car in their industrial training course. (Right) Field testing of a pilot model is an agricultural engineering job. In this case a new sugar beet harvester is under test

(Left) Fertilizing and disking a seedbed in one operation. (Right) A heavy-duty machine, in foreground, doing heavy work and a light machine, in background, on light work

serve as examples of that which is undesirable in personal characteristics. If the product of the university is to go into industry, the faculty must be carefully selected for its ability to turn out the right kind of material.

The college man in the past has been handicapped in industry because to some extent he has allowed an antagonistic feeling to be built up between himself and his fellow workers who have not spent as many years in formal education. All education is self-education. The university offers great assistance to the man who wishes to educate himself, but the university is not the only way to a real education, either technical or liberal. College graduates should recognize this. Records of college and non-college men in industry clearly indicate the greater importance of the individual and his desire to learn and to serve as compared to a strictly college and non-college classification. The college graduate has a real competitor in the industrial employee of his own age who has had a four or five-year head start.

The college student often arrives in industry with the feeling that the possession of facts and certain knowledge of their use is the all-important requirement for advancement. Soon he unhappily discovers that he is making little use of his many facts and theories laboriously accumulated during his college career. He feels that industry either does not appreciate him or is giving him a second dose of freshman hazing. He may be working under the direction of men with much less technical education. He is bewildered —he inquires about the men at the top, and to his dismay many of them are not college graduates. All through the organization he finds college and non-college men scattered in an indiscriminate manner.

College training must prepare the graduate for the big curriculum of life. College graduates should know that the quality of judgment gained through experience is the key that unlocks the door to advancement.

I recently reviewed a statement of a state university in which they listed their contribution to the industry of that state. Of the thirty items listed, twenty-eight dealt with research, while but two had to do with the training of young men or women. How do you visualize the word "industry"? When I say the word "dog", into the minds of all of you comes the picture of some kind of a dog. So when I say "industry" what is the picture—buildings, long rows of busy machinery, or trainloads of finished products? In my opinion, none of these portray industry. Industry is nothing more or less than the men who comprise it. Take any large industrial organization and destroy its factory and its product, and it will carry on, but entirely remove from any industry its men and you have destroyed that industry. Industry to live must continually add qualified men.

Should not superior teaching and the development of better men and women be considered as great an accomplishment or goal as good research? Good teachers should be compensated both in dollars and degrees fully as much as good researchers. Research is desirable, but in many institutions it is too much the central shrine toward which the entire faculty faces. Praise from the select group of fellow research workers tends to outweigh too often praise from students both in and out of college. Institutions are too rarely blessed with those great teachers whose influence lives on in the hundreds of lives they have affected.

There is some reason to believe that education in general in this country is undergoing a fundamental change. The early inhabitant was principally concerned with his ability to subdue nature and produce those things necessary for his existence. This situation undoubtedly had a most profound influence upon our early educational viewpoint and practices. We aimed our technical training at production. We were engaged in a contest of man versus nature.

While great changes take place slowly, and it is difficult to establish definitely a time when it may be said that a change has taken place, there is little doubt but what our primary job in this country is changing from one of ability to produce to one of ability to properly distribute and consume those goods and services which we have learned to produce so well. It is not that we have finished with our study of production, but it is rather that we must look more to the job of utilization.

In fact, the entire world is changing from a pioneering, moving, development age to an age where human relationships assume greater importance; the contest is changing from man versus nature to man versus man.

Industry's Responsibilities. The full responsibility for the success of the graduate, however, cannot be laid on the shoulders of the college faculty. Industry also has a responsibility. It must help men to find themselves. The introduction of college men into industry should not be a sink-or-swim proposition. Industry is recognizing this need in establishing well-planned training courses for new men.

A most interesting series of studies in personnel policy has recently been conducted by the National Industrial Conference Board. In their Report No. 4, they deal with matters affecting personnel of sales departments.

Under the heading of "Selecting and Training of Salesmen", they state that of 232 companies, mainly engaged in manufacturing, two-fifths do not stress educational back-

ground of the applicant as an essential factor in their selection, while one-fifth of the reporting companies specify that salesmen must have a college or technical school education. Of 40 manufacturers of machinery, which would include the farm equipment industry, 12 indicated no special educational requirements. *Fourteen* definitely *required* a high school education, 8 a technical school education, and 6 a college degree. *Sixteen* of the group *preferred* college graduates of a technical course.

In this same group of machinery manufacturers 19 out of 37 have company training courses for men entering and those now in their sales departments, and use these courses as their principal method of training. *Thirty-six per cent* of 215 manufacturing establishments reporting have company sales training courses.

In the fourth annual report of E.C.P.D. (Engineers' Council for Professional Development), there appears the following:

There are four normal stages in the life of the engineer: (1) pre-college, (2) the engineering school, (3) early experience as junior engineer, (4) professional practice.

In the first the high mortality of engineering students found by surveys a few years ago (40 per cent in freshmen year; only 30 per cent graduating at the end of four years) shows the need of better selection and guidance. In the second stage, the profession can do much to aid the schools; accrediting of engineering curricula is a most important step for assuring quality.

After graduation the future engineer who, as a student, has enjoyed a congenial environment with its prescribed lessons is likely to find the school of experience a harsh one. He is apt to lose his bearings, in a sort of no-man's land. The accompanying curve of an engineer's development shows horizontal progress just after graduation. Some industries have established training courses, helpful to the fortunate few. E.C.P.D. offers counsel and suggestion and ideals. It suggests what he can do to help himself and what aids are available. It aims to have active groups of junior engineers, sponsored by local engineering guidance. It attacks the most neglected and the most vital period in the development of the engineer in a definite, constructive and comprehensive way. It uses the counsel of experienced engineers and the plans formulated by committees of junior engineers.

There can be no doubt concerning the problem facing the young college graduate as to how to properly establish himself in industry. What is needed now is the solution of this problem.

A MORE INTIMATE AND UNDERSTANDING RELATIONSHIP BETWEEN EDUCATIONAL INSTITUTIONS AND INDUSTRY

Any college faculty member, or any committee of a college faculty, will find industry willing to cooperate. To a certain extent the responsibility for the solution of this problem is so completely common to both industry and the college it is likely that neither one feels it is their duty to start things. Certain representatives of industry do call on colleges and discuss matters pertaining to the training of undergraduate students. In a similar manner college men occasionally visit industrial organizations and discuss the matter of student preparation. But could not this matter be handled in a more complete and more direct manner? This Society could well afford to include in its program of important activities the establishing of ways to help the new agricultural engineering graduate in his first few years in industry. Here in A.S.A.E. is the logical meeting ground for all interested—the student, the college, and employer.

A few years ago the suggestion was made at a meeting of this Society that a college course for credit be established in which course most of the lectures would be given by representatives of those industries employing agricultural engineers. The content of such a course and its method of handling could well be the objective of a committee of this Society. Such a course should be given a trial at one or two institutions to determine its effectiveness. If in time a number of institutions included such a course, it would provide ways for representatives of practically all members of what might be termed the agricultural-engineering industries, to form a more intimate and understanding relationship with at least one college.

Such a committee might also attempt to work out ways whereby young agricultural engineers starting in industry could keep in touch with their former college professors, or, if preferred, a committee of this Society could register their experiences and constructive suggestions. In my opinion the move started by E.C.P.D., whereby junior engineers receive assistance from older members of local engineering societies, is indeed a most worthwhile enterprise.

THE KEY POSITION AND THE RESPONSIBILITY OF THE AGRICULTURAL ENGINEER IS RECOGNIZED

Agricultural engineering teaching and research, and the manufacturing, sale, and use of farm equipment are all related. Agricultural mechanization is the key that unlocked the door to modern living. In this profession the teacher, the manufacturer, and the user are closely bound together, largely due to the existence of the American Society of Agricultural Engineers. We are, therefore, inclined to recognize facts as facts, whether produced by the public servant, the manufacturer, or the user. There are those today abusing their position in public office who would try to make the public believe that the results secured by any study fostered by industry must of necessity be false. Those in public office in a democracy, state that they are placed in their position directly or indirectly by the votes of the people. All units of our industry are just as truly kept in their "office" by the votes of the people; votes in the form of dollars, votes cast by customers free to choose. Industries are voted out of office just as truly as presidents. The public office holder or the private industrialist who deals in fancy disguised as facts will surely meet his fate, as long as we maintain a free competitive system; as long as we are free to vote with our dollars or with our ballots, for the goods or men of our choice.

Agricultural engineering vision and technique released the world from the drudgery of long hours and heavy labor necessary for the production of the bare essentials for a drab existence. In China, so it is said, anyone who rescues a drowning man must continue to provide for him on the theory that the rescuer is responsible for the man's continued existence. The agricultural engineer should perhaps so consider his responsibility toward modern society. He has released men to invent, to build, to produce, to make available, and to prove the existence of the world's highest standard of living. The agricultural engineer has released the flood of goods and services which allows the people of the United States, who comprise but 7 per cent of the world's population and occupy but 6 per cent of the land, to carry on annually a domestic business among themselves, which represents 40 per cent of the entire trade of the world.

Is it not logical, therefore, that the agricultural engineer take the lead among the engineering professions in the directing of his attention and in the devoting of his energy along the lines of distribution and use of those products of invention and mechanization which he has directly and indirectly provided?

Forced Ventilation of Brooders

By Larry Moore

THE ACCEPTANCE of fan-ventilated brooders by poultrymen in the Northwest during the last three years has increased to such an extent that our best estimate from our own records, and reports of equipment dealers, indicates that 75 to 80 per cent of all electric brooders sold during the 1938 season were of the force-ventilated type.

Conventional overheat brooders as well as radiant-heat brooders had been used for a number of years with varying degrees of success. Many of the most successful operators were using hardware cloth screens beneath the overheat brooders to avoid trouble from so-called "sweating" of the chicks and collection of moisture on the floor, particularly near the curtains. Some operators were, and still are, going through successive seasons with little or no trouble from excess moisture under the brooders, while others were violently prejudiced against all makes of electric brooders because of experience with moisture collection.

In 1932-33 when fan-ventilated brooders were introduced by the Puget Sound Power & Light Company and Western Washington Experiment Station, the poultry industry was in a much depressed condition and not inclined to pay the $50 to $65 asked by manufacturers of the first fan-type brooders. About this time Oregon State College developed an underheat brooder using soil-heating cable beneath hardware cloth frames. The hardware cloth was supported about 4 inches above the brooder house floor. This brooder was developed with the two-fold purpose of providing the poultryman with a brooder that he could assemble at home at low cost from a standardized kit of parts, and at the same time produce a brooder that would overcome the moisture problem. This brooder fulfilled both purposes so well that, in the 1935 season, 80 per cent of all electric brooders sold in P.G.E. territory were of this type. However, reductions in the price of fan-type brooders and improved poultry conditions along with favorable experience with fan-ventilated brooders, later brought this type definitely into the lead.

Some of the brooders are of the same construction as used without forced ventilation. Conventional overheat brooders have been converted to force-ventilated brooders by placing a small motor-driven fan in the ventilator flue to force the air to reverse the natural thermal flow and flow out under the curtains. In these converted brooders as well as in the brooders designed for fan ventilation, it has been found necessary to place a baffle-plate below the ventilator flue to force the air over the heating elements and outward along the top of the brooder. The design of most of the fan-ventilated brooders has apparently been largely by guess. No information was available as to how much air should be forced through the brooder, either to supply the birds with ample fresh air or to insure moisture removal. Most manufacturers, as well as operators, feared that the use of fans to force air through the brooders would result in increased heat requirement. Consequently fans of very small capacity were used. However, experience soon showed that the use of fans reduced power consumption rather than increased it. Most manufacturers have since increased fan capacity and secured improved performance.

The only definite recommendation we have found as to the volume of air to be moved is in statements from J. C. Scott, agricultural engineer of the Puget Sound Power & Light Company, in which he says, "There should be at least twenty air changes under the hover per hour in order to keep the floor dry, according to our tests." While no data are furnished to indicate how the twenty air changes per hour affect temperature distribution or power consumption, experience was cited to indicate that general brooder performance was better with twenty air changes than with less.

One test at Oregon State College on a 6x6-ft flat-top, homemade fan-type brooder is summarized to show power consumption and temperature distribution, (1) with fan energized but blocked, (2) with low-pitch fan, and (3) with high-pitch fan. Power consumption with both fan and heater energized was 0.587 kwh per hr in No. 1; 0.432 kwh per hr in No. 2; and 0.386 kwh per hr in No. 3. Temperature distribution was poorest and temperature at chick height lowest in No. 1, second in No. 2, and best in No. 3. No data were gathered on volume of air moved. However, this type of brooder has operated satisfactorily under western Oregon conditions, showing no tendency to permit collection of moisture under the hover.

A single test on each of two different commercial, fan-ventilated brooders by means of thermocouples showed (1) that on a rectangular brooder 4x6 ft that temperature in the zone 6 in in from the curtains was 16 to 20 deg higher than at the center of the brooder, and (2) on a round brooder (67 in) the distribution was very erratic, varying as much as 26 deg between different thermocouple stations. Such limited and preliminary tests only serve to indicate that there is a lot we don't know about air movement and temperature distribution under so-called force-ventilated brooders.

More development work and tests on fan-ventilated brooders have been carried on by Puget Sound Power & Light Company agricultural engineers than any other one agency in the Northwest, if not in the entire country, so we cite statements received from Mr. Scott as being the most definite recommendations and specifications available for force-ventilated brooder construction and operation. Mr. Scott states "In the first place, we have found by test, that some of the so-called force-ventilated brooders, which are sold by some manufacturers, have no more air changes and no better air conditioning than the old type brooder with ventilation pipe up about 2 in from the top. In some of these brooders the pipe enclosing the motor and fan is so small that there is not sufficient room around the motor for enough air to pass through to do any good.

"Another thing, manually controlled dampers on the top leave such a small amount of open space that not enough air can be supplied to the fan and motor. These dampers in actual operation are often shut by the operator or partly shut with the idea that current consumption can be reduced. As a matter of fact, we have found that cutting off air will actually increase current *(Continued on page 352)*

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: Agricultural engineer, Portland General Electric Co. Jun. Mem. A.S.A.E.

Dehydration of Fruits

By E. M. Mrak

THE DRIED fruit industry of California is only about 75 years old, but during this period it has undergone a great expansion in production and world markets. In spite of this great development, the methods used for the production and handling of dried fruits have changed slowly. Some of the original procedures such as sun drying are still in common use. An outline of the procedures followed in sun drying and a list of the types of deterioration and contamination commonly encountered during sun drying are given in Table 1.

The finished dried fruit is stored in boxes, sacks, or large 20 to 30-ton bins. If improperly cured dried fruit is placed in storage, fermentation and auto-oxidation may cause the fruit to darken, develop gas pockets, become coated with a white yeast growth, or deteriorate in flavor. Insect infestation occurs on all fruits in storage so it must be guarded against at all times. Mechanical injury to dried fruits in packing houses is much more common in some instances than it should be, because of improper construction and methods of handling.

During the last 20 years the industry has been faced with many obstacles and changes that have necessitated the improvement of production methods and of the quality of the dried product. It is now well realized that in order to expand the American market and to maintain the foreign market in competition with cheaper dried fruits produced in other countries, it is necessary to improve the quality of California dried fruits.

Heavy rains during the drying season have injured the quality of dried fruits and caused great losses from decay and incipient fermentation to the prune and raisin industries (Fig. 1). A few disastrous seasons have encouraged many of the larger growers to discontinue sun drying and install dehydrators. The recent development of relatively inexpensive small dehydration units has also encouraged many of the smaller growers to utilize artificial drying.

In two instances the development of dehydration enabled certain producers to create new dried products, namely, Golden bleach raisins and dehydrated Clingstone peaches. In a span of about 15 years the production of Golden bleach raisins has grown rapidly. At present about 30,000 tons of these raisins are dehydrated each year. More than 15 new dehydration units are being installed this year for the sole purpose of producing Golden bleach raisins. While the dehydration of Clingstone peaches has not reached the proportions of the Golden bleach raisin industry, nevertheless a considerable tonnage of Cling peaches is dehydrated each year.

The activities of the federal food and drug administration have compelled growers to produce dried fruits practically free of dirt, insect infestation, mold, fermentation, and spray residues such as arsenic and lead. This situation has necessitated the creation and development of sand shakers (Fig. 2), fumigation chambers, washers, and inspection and testing methods. It has also encouraged the use of dehydration in certain instances, because, if fresh fruit is clean and free of infestation and fermentation when introduced into a dehydrator, it is in similar condition when removed from the dehydrator. This is not usually true when fruit is dried in the sun.

The rather recent combined and coordinated efforts of chemists, microbiologists, entomologists, and engineers have resulted in improvements in methods of harvesting, preparation for drying, drying, and storage that are responsible for the improvement in the quality of dried fruits now sold. The remainder of this paper, however, will be devoted only to the developments and improvements in the artificial drying of fruits.

Practically all fruit drying in California prior to 1917, except for apples, was accomplished by exposing the fruit on trays to the sun for several days. Apples, on the other hand, have always been dried in natural draft evaporators or occasionally in more modern dehydrators (Fig. 3). Drying in old-style evaporators is slow and inefficient and does not produce a uniform product. In recent years it has been found that, if a small propeller type fan operated by a small motor is placed in the roof vent of the natural draft evaporator, the drying time may be decreased by one-fourth and the uniformity of the product greatly improved. These fans draw the air upward from the heater through the drying fruit and out of the vent. A few measurements made in hop kilns equipped in a similar manner indicate that

Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: Division of fruit products, University of California.

FIG. 1 (LEFT) DRYING FIELD AFTER RAIN. THE TRAYS ARE INCLINED IN ORDER TO FACILITATE DRYING. DEHYDRATION ELIMINATES THE DANGER OF RAIN AND THE EXPENSE OF STACKING AND INCLINING THE TRAYS DURING AND AFTER A RAIN. FIG. 2 (RIGHT) RAISIN SHAKER USED ON THE FARM TO REMOVE SAND AND INSECTS FROM FRESHLY DRIED RAISINS

about 200 to 250 lineal feet per minute of air passes through the hops. The rate of air flow through the product being dried depends on many factors which have not been studied because of the newness of the installations.

A few rather unsatisfactory attempts were made in California to dry prunes in natural draft kiln and rotary bake oven type driers. The natural draft Oregon tunnel type of drier has found wide uses in Oregon because of the wet drying season (Fig. 4). In recent years these driers have been equipped with forced draft which has proven to be a decided improvement, although such driers are still inefficient and expensive to operate. A number of these driers were built in California, but in most instances were used only for emergency purposes.

The great increase in the use of dehydrators for the drying of fruits in California followed the introduction and development of forced draft tunnel type driers. The construction and operation of these dehydrators has been discussed in detail by Christie (1926), Christie and Ridley (1923), and Nichols et al (1925). Although forced draft and recirculation are used in most tunnel dehydrators, the methods of heating and conducting air flow through the plants vary considerably with the dehydration units sold by different manufacturers.

The air to be passed over the drying fruit is heated by direct heat, direct radiation, or indirect radiation. By direct heat is meant the addition of heat units generated to the air used in drying by direct mixing of the products of combustion and the air without the intervention of furnace walls or flues (Fig. 5). This can only be done where there are no combustion products that might damage the fruit. This heating system is particularly well adapted to the use of natural gas as a fuel. Oils are commonly used, but a careless operator may easily damage a charge of fruit. It is impossible to use coal or wood in direct-heat systems. The advantages of direct heat are high fuel efficiency, 90 to 100 per cent furnace and 36 to 50 per cent overall efficiency, low cost of installation and upkeep, and instantaneous temperature regulation because of the absence of stored heat. The disadvantages of direct heat in fruit dehydrators are the possible contamination of fruit by products of incomplete combustion and the necessity for a high-grade fuel.

Direct radiation as used in dehydration refers to the absorption of heat by air from burning fuel by direct radiation through the furnace wall, flues, or radiators (Fig. 6). This system offers the advantages of being clean and permitting the use of any kind of fuel. The overall efficiency of direct radiation systems ranges from 32 to 45 per cent, whereas the furnace efficiency usually ranges from 80 to 90 per cent as compared with 90 to 100 per cent for the furnaces in direct-heat systems. The disadvantages of direct radiation for the dehydration of fruit lie in the expense of installation, lack of instantaneous temperature regulation owing to temporary heat storage and the lower fuel efficiency resulting from stack losses.

Indirect radiation or the generation of heat at a distant point and its transportation to a point at which air is to be heated by means of steam or hot water radiators is rarely used now. It may be found occasionally in some of the antiquated apple-drying plants. The advantages of such a system are automatic regulation, no limitation of the type of fuel that may be used, and the distribution of radiators where desired.

The great disadvantages to indirect radiation are the expensive installation and upkeep and low fuel efficiency. The furnace efficiency usually ranges from 60 to 70 per cent and the overall efficiency from 24 to 35 per cent. Some operators have also considered the necessity of heat regulation, both at the furnace and at the radiators, a nuisance and a disadvantage.

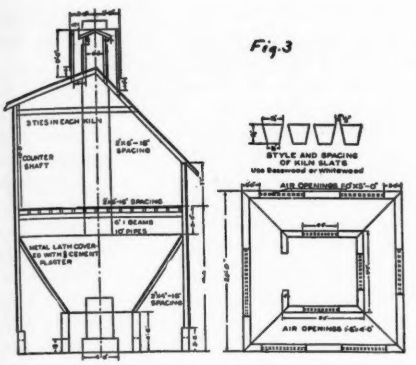
The counter current and combination air movement systems are in most common use today, but the parallel current and constant temperature air movement systems also have been used to some extent in the dehydration of fruits and vegetables.

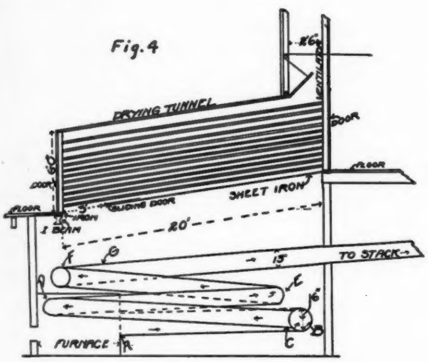
When the counter current system is used the air and fruit move in opposite directions through the drying tunnel (Fig. 6). The fruit enters at the cool end of the tunnel and leaves at the hot (critical temperature) end of the tunnel. By moving the fruit from the cool end to the hot end of the tunnel gradually the rate of drying is not so rapid that undesirable color and flavor changes are apt to occur. Furthermore, it favors the maximum use of heated air in the long chamber, and hence the maximum power and fuel efficiency.

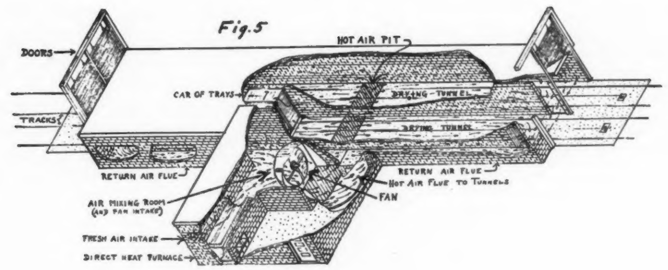
In the combination system of air movement the air flow is so arranged that the highest (critical) temperature is at

TABLE 1. OUTLINE OF PROCEDURES FOLLOWED AND TYPES OF DETERIORATION ENCOUNTERED DURING THE SUN DRYING OF FRUITS

Fruit	Pretreatment	Drying practice	Treatment during drying	Drying time (days)	Contamination and deterioration that may occur during sun drying
Prunes	Short dip in hot dilute lye solution	On wood trays in dry yard	Imperial prunes (large) turned to prevent molding	7—14	Insect infestation. Microorganisms and fermentation. Enzymatic changes. Auto-oxidation and darkening. Dust and dirt.
Figs	Sometimes sulphured	As above if not dry when harvested	None	0—7	Same as above
Natural raisins	None	On paper or wood trays in vineyard	Sometimes turned	10—25	Same as above
Soda dip raisins	Short, dilute alkaline dip	On wood trays in dry yard	As above	10—20	Same as above
Sulphur bleach raisins	Sulphured	As above	None	10—20	Insect infestation. Dust and dirt.
Apricots	Cut, pitted sulphured	As above	None	2—8	Same as above
Peaches	Cut, pitted sulphured	As above	None	4—8	Same as above
Pears	Spray residue removed. Cut, stemmed, sulphured	As above	None	14—25	Same as above
Nectarines	Sulphured	As above	None	4—8	Same as above







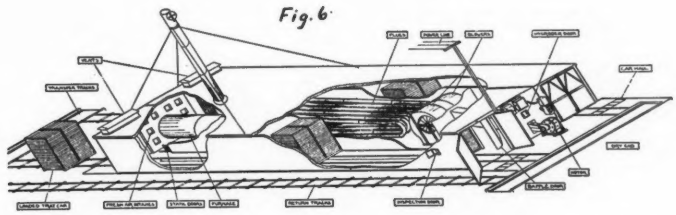


FIG. 3 OLD KILN-TYPE EVAPORATOR. SEVERAL OPERATORS HAVE INSTALLED PROPELLER FANS IN THE ROOF VENT TO ACCELERATE DRYING BY DRAWING AIR THROUGH FRUIT PILED ON THE FLOOR. FIG. 4 OREGON TUNNEL TYPE EVAPORATOR. FIG. 5 CUT-AWAY DRAWING OF A DEHYDRATOR SHOWING USE OF DIRECT HEAT AND THE COMBINATION AIR FLOW SYSTEM. FIG. 6 CUT-AWAY DRAWING OF A DEHYDRATOR SHOWING USE OF DIRECT RADIATION AND THE COUNTER-CURRENT AIR FLOW SYSTEM

the center of the drying tunnel. The tunnel may be straight with the air flowing toward the ends from the center (Fig. 5), or it may be U-shaped with the air flowing from the bend in the U toward each end. In either case the fruit enters at a lower temperature and moves toward the hotter air at the center, reaching it after about half of the drying period is completed. Then the fruit moves past the center and finishes drying at the second cooler end of the tunnel. Although this system is used rather extensively, it is more difficult to control than the more simple counter current system. If the temperature at the center is allowed to exceed the critical temperature, overdrying, injury, and loss in yield may result unless all pieces dry at the same rate.

When the parallel current system of air flow is used, the fruit enters at the hot end of the tunnel and moves in the same direction as the air flow. This system seems satisfactory theoretically from the standpoint of rapid removal of water and critical temperature, but it is unsatisfactory from the practical standpoint of evaporation of water from the fruit. Water is most easily evaporated from fresh fruit and with greatest difficulty when it is nearly dry. A high initial temperature often causes bleeding or exudation of juice from the fruit with a resulting loss in yield, slabbing of fruit and loss in quality.

The constant temperature or cabinet system is rarely used and is of value only when small plants are drying a variety of products, such as vegetables, and it is desirable to keep them in separate drying cabinets. Each car of fruit remains at the same temperature throughout the drying period. The method is inefficient and expensive from the standpoint of labor.

In most dehydrators the air is drawn from the heating chamber and forced through the drying chamber under pressure. This gives a more positive air distribution and better temperature control than if air is drawn through the drying chamber. A good air flow is necessary and usually should not be less than 500 lineal feet per minute. Christie has classified air velocities between trays in tunnel dehydrators as follows: Below 400 lineal feet per minute, poor; 400 to 600 ft, good; 600 to 800 ft, excellent; 800 to 1000 ft, exceptional, and above 1000 ft, uneconomical. In order to obtain these air flows, various types of fans have been tried, but until recently the multivane fan had been considered the only fan capable of yielding a velocity pressure sufficient to give the air flow mentioned above. A serious objection to the multivane fan has been its cost of installation and operation. This has prevented many small growers from installing dehydration units. Recently an improved type of propeller fan has been used in dehydrators with apparent success. Although data concerning cost of operation and air flow yields of these new fans are not available, it is definitely known that very small motors are used for their operation, that dehydration plants can be built for a third or fourth of what they cost before these fans were used, and that plants equipped with these fans have been operating with apparent success for at least two years. In view of this encouraging information it appears that this new development is worthy of consideration by dehydration engineers. These fans are also being used in nonrecirculating tunnel and kiln evaporators with a certain degree of success.

The effectiveness of a dehydrator fan depends to a considerable extent on the course of air movement. When the air is forced through narrow channels back and forth across the tunnel as is done in some cases it is necessary to use fans capable of overcoming the static pressure. In some instances two fans or lateral as well as terminal fans are used.

The volume of air has no effect on quality, but uniformity of distribution may be important in obtaining uniform drying. The rate of air flow however, is very important from the standpoint of dehydrator capacity. More rapid

air flow induces faster drying, and hence greater capacity and less cost per ton for power, fuel, and labor of operation. If the length of the drying tunnel is increased, the velocity of the air flow should also be increased correspondingly in order that the temperature drop and humidity increase will not be so great as to prevent drying at the cold end. The temperature drop is dependent on the relative volumes of air and fruit and the rate of evaporation from the fruit. Dehydration tunnels for prunes can be 50 to 60 ft long because the temperature drop is usually about 1/2 F (degree Fahrenheit) per foot, whereas apple dehydrators can only be about half as long, because the temperature drop in this case is about 1 F per foot.

In most dehydrators it is customary to recirculate as much air as possible in order to obtain a maximum fuel efficiency. On the other hand, recirculation is sometimes minimized during the rush season in order to reduce the drying time. This practice has often caused inexperienced operators to suffer great losses resulting from "case hardening" and ultimate microbiological and chemical deterioration. Case hardening is the condition in which the outer layer of cells give up their moisture more rapidly than moisture can diffuse from the inner cells, and the result is a layer of dessicated cells on or near the surface. In order to prevent case hardening the relative humidity of the air must be adjusted in accordance with the rate at which the fruit tissues give up their water. The diffusion of moisture out of the fruit varies with the variety, maturity, size of pieces, season, and general condition of the fruit. These factors should be taken into consideration by the dehydrator operator. Last season a considerable tonnage of fruit was case hardened because of improper operation of dehydrators. During subsequent storage in bins, the moisture diffused slowly from the center of the fruit into the case-hardened layers. Eventually the moisture content of the surface layers of the fruit was sufficiently high to support mold and yeast growth and to permit discoloration resulting from enzymatic and auto-oxidative changes. The result was the spoilage of a considerable tonnage of dried fruit.

A dehydrator humidity in excess of 25 per cent causes most fruits to dry slowly, and may cause injury to color and flavor. Below 15 per cent, drying is little faster and the fuel economy is notably reduced. If fresh fruit such as prunes is placed in a warm air of high humidity which heats and expands fruit but does little or no drying, it will burst, bleed, become sticky, and dry slowly. In general, the humidity at the cold end of the tunnel should not exceed 60 to 65 per cent in order to permit drying to start immediately.

In conclusion, it may be said that the dehydration of fruits in California is definitely increasing from year to year. The advantages of dehydration over sun drying and the development of the relatively inexpensive dehydrators with propeller fans, and that burn natural gas, have greatly stimulated the installation of dehydration units by small growers. The latest dehydrators burn natural gas and use direct heat in order to reduce the cost of installation. Some of the newer plants appeal to growers because they can be operated in one of three ways, namely, as double straight-tunnel driers, or combination driers, or as single-tunnel driers.

The great advantages of dehydration over sun drying are: (1) it produces a dried fruit of better quality than is obtained by sun drying; (2) the yield of dried product is greater than when fruit is dried in the sun because of smaller losses resulting from fermentation and respiration; (3) it is an insurance against rain damage losses; (4) it reduces the drying time from several days to about one day; (5) it is much more sanitary than sun drying; (6) it is a protection against infestation by field insects, and (7) the total costs including fixed charges need not be greater than those of a dry yard of equal capacity.

The main disadvantage of dehydration is that it requires more skill than sun drying. Consequently there is the possibility of improper operation resulting in poor quality or spoiled fruits. A second disadvantage at present is that it is not possible by dehydration of such fruits as freestone peaches, apricots, nectarines, and pears to secure products similar in appearance to the sun-dried product unless they are first exposed to the sun for a day in order to fix the color of the fruit. Although flavor is not affected, this has definitely hindered the use of dehydration for these fruits and until engineers or chemists develop methods to solve this problem, sun drying will be the accepted means for drying cut fruits. Attempts are being made to fix the color with ultra-violet light before dehydration, but the value of this treatment is still questionable.

ACKNOWLEDGMENT. The author wishes to express his appreciation for the assistance received from Professors J. D. Long and W. V. Cruess in the preparation of this paper.

REFERENCES

Christie, A. W. (1926). The dehydration of prunes. Calif. Agr. Expt. Sta. Bul. 404; pp. 1-45.

Christie, A. W. and C. B. Ridley. (1923). Construction of farm dehydrators in California. Jour. Amer. Soc. Heating and Ventilating Engineers 29, 687-716.

Nichols, P. F., Ray Powers, C. R. Gross and W. A. Noel. (1925). Commercial dehydration of fruits and vegetables. U. S. Dept. Agr. Bul. 1335, pp. 1-40.

Forced Ventilation of Brooders

(Continued from page 348)

consumption to quite an extent. In other words, there must be enough air forced into the brooder to drive the heat down and out at the sides. Otherwise heat will bank up to the ceiling to such an extent that it is lost by radiation. Furthermore, the floors in such instances are damp and cool. I have noted recently bulletins giving the results of tests of supposedly forced-ventilation brooders from eastern experiment stations, and from the data given and results obtained I do not believe that they have a properly operating forced-ventilation brooder."

Mr. Scott says further, "It is very important to follow the exact description of the damper according to our tests. The damper must be made of aluminum and must swing back as described (in plans) in order to get the proper amount of air into the hover. The damper must not fill the entire area of the pipe. We had better results in air circulation and even distribution of temperature with the damper arranged as shown in our plans than when we took the damper off entirely.

"Many operators lower the curtains too much. They should be at least 2½ in from the floor. We have one manufacturer near Bellingham, who three years ago put out a good many brooders without curtains. The bottom of the apron was 3 in from the floor, the apron consisting of wood side instead of curtain material. This gave us so much better results that we have been recommending this idea."

Not disregarding the progressive leadership of Mr. Scott and his associates in developing and testing force-ventilated brooders, it would seem that both manufacturers and experiment stations might well devote more time to definite establishment of the important design factors for force-ventilated brooders. The upper limit of volume of air movement should be established as definitely as possible considering temperature distribution, comfort and health of the chicks, moisture control, and operating economy.

Equipment for Plant Disease Control

By V. H. Matthews

IN MANY of its features, the sprayer offers engineering problems unique in the agricultural or any other field. It is equipment, the proper and timely use of which, more often than not, is the deciding factor in the annual loss or profit of its owner. It must be ready for efficient operation on the exact day when all conditions, both as to disease control and spraying operations, are right. Yet it stands idle a very large part of the year, and its pump and engine have many parts which inherently deteriorate and become inefficient through disuse.

It must handle materials that are, practically without exception, both corrosive and abrasive, yet it must produce pressures that require accurate fitting and precise action of all parts, if it is to operate with even reasonable efficiency. It must have mechanical features that are rather complicated, exacting of working detail and conditions; yet it must be operated by men of certainly not more than average mechanical understanding and ability.

It must work under external conditions commonly combining destructive dirt and moisture factors, yet it must have its parts accessible for quick and easy inspection and adjustment. It must carry a maximum amount of spray solution, yet have over-all measurements which enable its passage through low hanging trees or close planted vegetables. Its weight and balance must permit its use on flat ground or rough hillsides; it must turn short, and its wheels must carry it over dry, wet, plowed, or sod ground. Its method of filtering and its system of agitation must handle all manner of mixtures and materials.

With all these conditions to be met, what has engineering ingenuity accomplished in the last twenty years? Among such results may be listed the following advances: (1) Working pressures have been raised from 250 to around 800 lb per square inch; (2) maximum pump capacities on portable outfits have increased from 10 or 12 to 50 and 60 gpm; (3) average pump and engine weights have been reduced by approximately 50 per cent for any given capacity; (4) the average tank size has been increased from 150 or 200, up to 300 and 400 gal, with 500, 600, and even 800 gal becoming more ordinary, and (5) common daily output, and consequent crop protection, has been increased from 1600 or 2000 gal up to 4000 to 6000 gal per outfit.

What of the cost of present-day sprayers? How do the sprayers of today compare, in this respect, with the machines of 10 and 20 years past?

To make any direct comparison between selling prices in those periods is difficult. As just stated, tremendous changes have taken place in the design of practically all parts of the sprayer. I believe, however, that we can still accept the ability of any outfit to produce a given capacity and maintain a given pressure, as an all-important detail.

Working on this premise, suppose we devise a unit of comparison, and consider as one unit the sprayer's ability to pump one gallon of material per minute at 100 lb pressure. On this basis, a machine capable of delivering 3 gpm at 200 lb pressure, would be credited with 6 units; a machine delivering 10 gpm at 600 lb pressure, would be credited with 60 units.

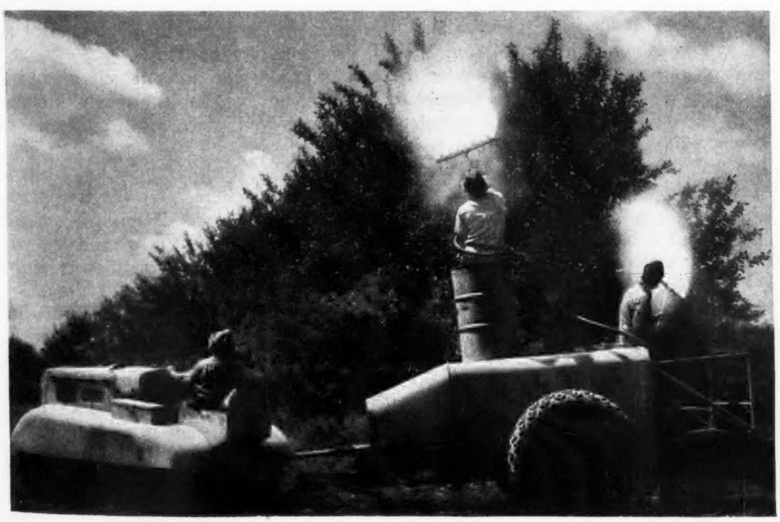
Using this plan, I have checked through the catalogs and price lists of several prominent manufacturers, and have taken from each several sizes of outfits ranging in capacity from 6 to 50 gpm. After obtaining the published selling price, I have divided it by the number of units to obtain the price per unit. Then I have averaged the price per unit for the several sizes, and got the results shown in Table 1.

This is not an accurate comparison, but it does serve to give a general view of progress made. Since 1928 the enclosed pump, the all-steel sprayer, antifriction bearings, pneumatic-tired wheels, and tremendous increase in average tank size have all appeared in manufacturers' specifications. These refinements make for greater convenience and longer-lived machines, but do affect the unit price.

Greater tank capacities effect real operating economies, by reduction in necessary refilling time, but may require more costly chassis design, and again the price, as based on our unit, is increased.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 30, 1938.

Author: Manager, John Bean Manufacturing Co. (California)



Spraying for plant disease, insect pest, and weed control offers a difficult problem in engineering improvement to produce more standardized equipment, with greater range of capacity and adaptability, at lower first cost, and with lower operating cost. Important factors in operating cost are labor, power, and transportation of water

TABLE 1. SPRAYER SELLING PRICES REDUCED TO PRICE PER UNIT*

Year	Average selling price	Average number of units	Average price per unit
1918	$380.33	15.83	$29.23
1928	812.00	68.44	13.92
1938	831.66	127.5	6.52

*One unit equals ability to deliver 1 gpm at 100 lb pressure.

What affects sprayer costs? Of course, materials, labor, and all the usual manufacturing and sales expenses have their effect. Volume of production, as in all other manufacturing processes, is of vital importance. It is interesting to note the small annual volume of sprayer sales, as compared with other common agricultural items of equipment. The following tabulation is taken from a May 5, 1938, bulletin of the Bureau of the Census:

TABLE 2. DISEASE CONTROL EQUIPMENT SALES COMPARED WITH OTHER AGRICULTURAL IMPLEMENTS (1937)

	No. of manufacturers reporting	Units sold	Value
Power sprayers (not including engines)	17	9,140	$1,932.340
Power spray pumps	10	2,997	417.508
Power dusters	11	2,193	335.921
TOTAL		14,130	$2,685.769
Grain binders	6	54,668	9,248.324
Grain drills	16	57,272	7,033.078
Manure spreaders	13	58,191	6,964.683
Mowers	13	115,099	7,354.422
Farm wagons	36	58,725	3,731.651

By this recitation of the problems of sprayer design and manufacture, you may have already concluded that I am mainly interested in discouraging new competition for those concerns already in business. Table 3 shows the real production and cost headache. This table represents actual figures taken from one manufacturer's production records for last year. Since, however, the catalogs of all prominent manufacturers list almost identical numbers of sprayer models, in practically the same capacity distributions, their problems in this regard are probably also identical. In any event, it shows a bad situation, brought about by a feeling among fruit growers that their individual working conditions are invariably different than those of any of their neighbors, and require different sprayer specifications.

Anyone at all familiar with principles of factory production can readily see that such a multiplicity of models, and such small percentage of production in any one group, can only mean high costs to everyone concerned.

It is small wonder, then, that it takes real courage for the average manufacturer even to talk to the almost daily visitor who proposes a new type of machine, spray gun, or other detail. Yet every sizeable plant I have visited has its experimental department, wherein engineers and other workers are steadily employed in an endeavor to both work out suggested improvements in present type equipment, and to test the more promising theories for new principles of general spray applications. It is their job to originate, as well as to augment similar work being done in the many agricultural experiment stations of the country. It is their job to reduce to commercial practicability, if possible, the ideas explored from a scientific viewpoint in those stations, or occasionally originated by some orchardist or vegetable grower.

TABLE 3. PORTABLE POWER ORCHARD SPRAYERS

Per cent of total volume in each class

Gpm	Tank size, gal 50	100	150	200	300	400	500	Over 500	Total, per cent
Portable-engine drive									
40-50						2.	1.	0.5	3.5
30-40					5.8	2.5			8.3
20-30					8.2	8.	0.8		17.0
15-20					6.	6.2			12.2
10-15				0.7	9.7	0.2			10.6
X-10	1.6	3.4	3.4	1.2					9.6
									(61.2)
Tractor-trailer									
40-50							3.	2.	5.
30-40							1.6	0.9	2.5
20-30					2.5	1.8			4.3
15-20				0.3	6.5	1.4			8.2
10-15				0.5	2.0	1.3			3.8
									(23.8)
Motor truck									
40-50							0.2	0.2	0.4
30-40					1.2	1.	0.4		2.6
20-30					4.	2.			6.0
15-20					2.	0.5			2.5
10-15					2.1	1.4			3.5
									(15.0)
Total									100

To find methods, or equipment, which will give good results experimentally is one problem. To develop either of them to a point where they can be commercially produced and commercially used in a general way is quite a different task. So we find that in the past forty years nothing has seriously threatened the prestige of water as a carrier for spray materials, nor of the displacement type pump as the agent for producing the spray with which to apply them.

Other methods, like dusting in its various forms, have worked out well under certain conditions or for specialized purposes, but have not been generally successful as a cure-all in the hands of the proverbial Tom, Dick, and Harry. Except as special equipment for those operators large enough to afford them, conservative manufacturers therefore hesitate to recommend them. Even then, they must carefully weigh their problems incidental to their responsibility for keeping available full stocks of repair parts over a long period of years after the last machine of any given model is sold. Difference in responsibility in regard to this repair part service, rather than the first profit made on the sale of the machines themselves, explains why the well-established firms often seem slow, and the corner blacksmith so aggressive and ingenious, in the building of equipment to meet local, special, or temporary needs.

I wonder if we, as a group who are sincerely interested in the welfare of the fruit and vegetable growers throughout the country, might not well place more emphasis on these four points:

1 That we recognize quite readily the faults of a program for disease prevention which requires the transportation of large quantities of water over all sorts of orchard and crop-raising terrain; which requires as much power, as much complicated equipment, and as many other attendant difficulties as does the standard sprayer of today.

2 That we encourage to the utmost a thorough trial and development program to cover any substitute method that may show promise, but keep all investigational work strictly on that basis until we can clearly demonstrate its ability to generally replace our present equipment for the greater financial profit of ultimate users as a class.

3 It is not difficult to see that, if the manufacturer could reduce the number of sprayer models he is building, the user would benefit tremen- *(Continued on page 358)*

Use of Models for Structural Design

By James R. Griffith

THERE are only a few fundamental methods available for the analysis of any structural member, although many special ways exist for applying them. We might say the fundamental methods of structural analysis are (1) the conditions for static equilibrium, and (2) deflection. In the more elementary structure, the conditions for static equilibrium are sufficient for the analysis, although different special tools exist for their application, such as (1a) the method of joints, (1b) the method of sections, (1c) the method of shear, and (1d) the method of moments. They may be applied analytically or graphically. When these tools are inadequate for any analysis, the structure is said to be "statically indeterminate", and the second method, "deflection", must be applied.

There are many specific tools for applying the principles of deflection in the analysis of a structure. Some of the better known methods are (2a) slope deflection, (2b) area moments, (2c) conjugate points, (2d) distributed moments, (2e) least work, (2f) strain energy, (2g) elastic weights, and (2h) models.

Models are only one special tool for applying the principles of deflection to a structure. They are no panacea for all the difficulties of structural design, for, like most tools, they have their limitations. The well-equipped engineer should be able to use that method best suited to the difficulties of the problem in question.

Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Professor of structural engineering, Oregon State College.

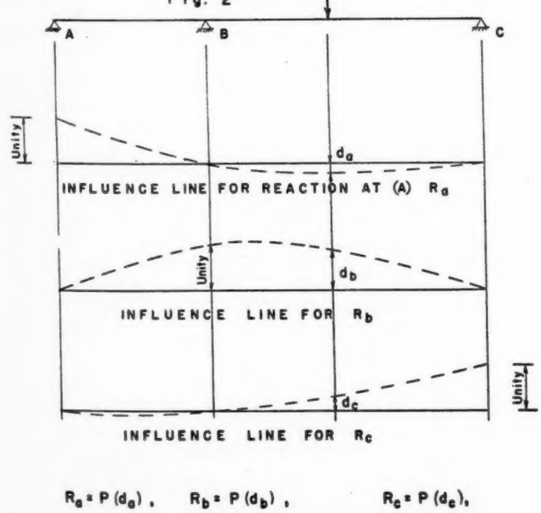
There are two major types of structural models, namely, two-dimension models and three-dimension models. In the two-dimension type, a single cross frame or truss, involving only breadth and height, is fabricated. In the three-dimension type, a model of the entire structure is built, with length as an additional factor. While both types are devices for applying deflections, they are further subdivided into loaded and unloaded models, each involving a radically different type of solution. The applications of loaded two-dimension models are relatively rare, although a description of one appeared in AGRICULTURAL ENGINEERING for May 1938. An excellent example of the loaded three-dimension model will be found in the tests of the San Francisco-Oakland Bay bridge.

Since the entire field of structural models is entirely too extensive for this discussion, I shall confine myself to the more elementary type, the unloaded two-dimension model. Much space in engineering literature has already been devoted to the theory and mathematics of such models, so I shall limit myself to a demonstration and application of the principles. Sufficient fundamental references will be included in the bibliography for those desiring more information on the subject.

The first practical method for utilizing structural models was presented by Professor George E. Beggs of Princeton University in 1922. The method appealed to me as a way out of some of my difficulties in 1924, and was used to design the Illinois Central catenary structures, this being the first commercial application of the method. In 1926 Otto Gottschalk described his continostat, utilizing steel splines for the application of the same principles. However, both

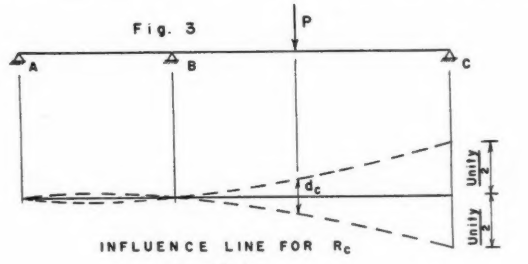
Fig. 1

Fig. 2



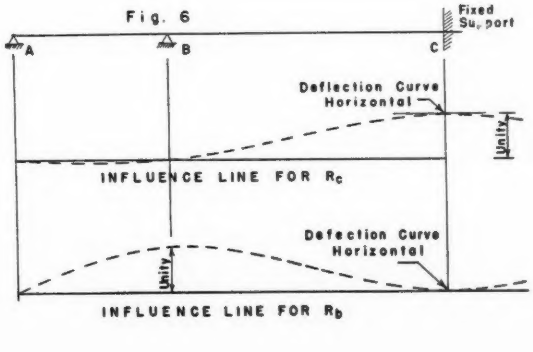
$R_a = P(d_a)$, $R_b = P(d_b)$, $R_c = P(d_c)$,

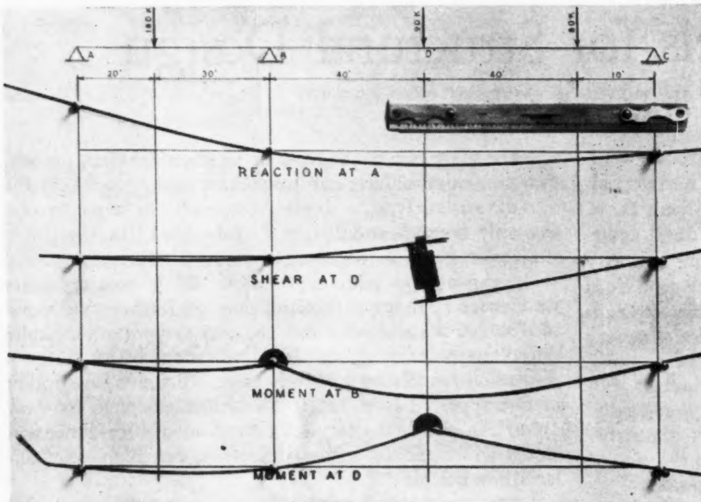
Fig. 3

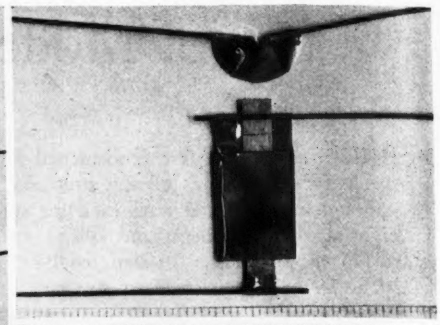


$R_c = P(d_c)$

Fig. 6







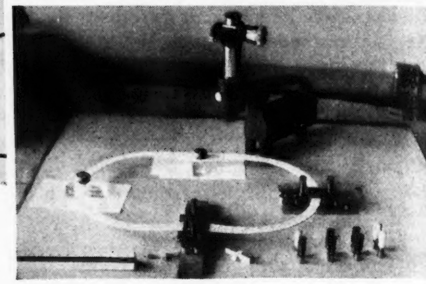


FIG. 4 (LEFT) MODEL STRESSES AND INFLUENCE LINES. FIG. 5 (UPPER RIGHT) CLAMPS TO PRODUCE INTERNAL DEFLECTIONS. FIG. 7 (LOWER RIGHT) BEGGS' CARDBOARD MODEL TESTING EQUIPMENT

these commercial sets were entirely too costly for the average engineer to own, and I began trying to find some inexpensive equipment for utilizing the principles. While with the Westchester County New York Park Commission in 1927, I found steel piano wire satisfactory for the solution of continuous beams, except that such wire could not be obtained in a straight condition. In the same year Anders Bull described his use of brass drill rod to construct models.

The most satisfactory material I have experimented with has been the bronze rod used for gas brazing. Low cost, availability, elastic properties, and workability are the principal advantages of this material. When its range of available sizes is inadequate, gas welding rod may be used to overcome that deficiency.

Aside from the use of models to analyze a structural frame, I have found another instructive application. Students, and even some engineers, forget that beams and columns are all fastened together in a structural frame. Models can be used effectively to demonstrate how deflections are distributed to adjacent members. The relative value of some questionable brace can even be checked by applying transverse loads to such models.

In the direct use of the unloaded two-dimension model, stresses or reactions are obtained by first constructing the influence line of that function. While thinking exclusively of a mathematical treatment, D. B. Steinman in 1916 stated the general principles later utilized in models of this type: "The influence line for any reaction, shear, bending moment, or stress is identical with the deflection diagram produced by a unit displacement at the point of application and in the direction of the desired reaction, shear, bending moment, or stress." Beggs makes very small deflections of cardboard models and reads the ordinates of the influence line by micrometer microscope. Gottschalk with his continostat and steel splines makes deflections large enough to see and measure. Whether using the methods of Beggs, Gottschalk, or models of wire, the same principles apply. Each is simply a special device for accomplishing the same purpose, and no single one has all the advantages.

The principles can best be demonstrated by applying them to that most elementary structure, the continuous beam. If the beam is of uniform section through its entire length, a single wire of uniform section may be used for a model with push pins for supports. If the reaction at "A", Fig. 1, is deflected a unit distance, the deflection diagram thus produced is the influence line of that reaction. The ordinate at any section is then the reaction at "A" for a unit load at the section where the ordinate was taken. Fig. 2 shows influence lines for all reactions of a continuous beam having three reactions. The reaction for any specific load is then the product of the load and the ordinate at the load taken from the influence line of that reaction. The reaction from a combination of loads is the summation of individual products.

Since it is physically impossible to obtain wire that is absolutely straight, errors due to irregularities of alignment must be guarded against. Such errors may be eliminated by making a one-half unit deflection on both sides of the origin, Fig. 3. While this double deflection increases accuracy, increased care is necessary to obtain the correct sign. The linear value for the unit deflection may be any convenient amount, providing the elastic limit of the wire is not exceeded. A deflection equal to one-third the shortest adjacent span, is about the maximum that can safely be made. It is possible to increase the size of ordinates without producing an excessive deflection of the wire by making this double deflection.

In the previously mentioned method of "sections", a portion of the structure is cut away and stresses applied at the cut section applied as external reactions to satisfy the conditions of static equilibrium. Thus, the same methods of obtaining influence lines may be extended to include internal stresses. A unit vertical displacement at section "D", Fig. 4, produces the influence line for shear at section "D". Likewise, a unit rotation at "B" produces the influence line for moment at section "B".

Fig. 5 shows in larger detail the clamps used to produce internal deflections. The moment clamp is my own development, while that for shear was made at my suggestion by Ray deLancy, while a student. The tin is bent around the wire for snug fit and soldered in place, care being taken to prevent the solder from contacting the wire and prevent-

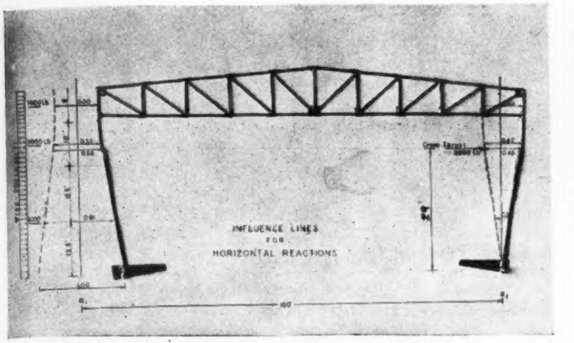


FIG. 8 MILL BUILDING FRAME MODEL UNDER TEST FOR HORIZONTAL REACTION TO WIND LOAD AND CRANE THRUST

ing its removal. The shear clamp is fabricated from three layers of tinned metal, and is adjustable for a reasonable range of unit values. Since the moment clamp is not adjustable, it is necessary to have several clamps with a range of values of rotation. Any angle of rotation will suffice so long as its value is known and it does not produce an excessive deflection. Moment clamps are calibrated in terms of the coefficient necessary to multiply the measured ordinates for the correct moment values. Due to the slight play usually present in the clamp, the calibration can be more accurately accomplished by actual application to a specific beam where the moment is either known or can be figured.

When measuring the ordinates of the various influence lines for reaction and shear, the same scale must be used as for laying out the unit deflection. In the case of the influence lines for moment, ordinates are measured to the same scale as used for the span of the model.

Fig. 6 illustrates the method used to obtain the reactions of a continuous beam when one end is fixed. As in the analytical solution, the slope of the deflection curve must be horizontal at the fixed reaction. Otherwise the solution is the same as previously described.

The same principles may be applied, with limitations, to any structural frame. Beggs' deformiter gages permit of much more general application, as the model may be cut at any section. Fig. 7 shows a cardboard model with the Beggs equipment being used to analyze a section taken through the intersection of a 48-in water pipe Y where the uniform internal pressure produces flexural stresses.

Wire models are constructed by soldering the wire at joints to pieces of tinned metal, similar to gusset plates in a riveted structure. The various members are calibrated as Anders Bull describes in detail, measuring the deflection of the various wires for equal cantilever span and loads. The reaction plates are made of the same tinned metal with drilled holes for the push pins. In fabricating a model, I first draw the frame to scale on detail paper; attach the reaction plates by push pins; then, starting with the column wires, hold each wire in place by weights until soldered to the plate.

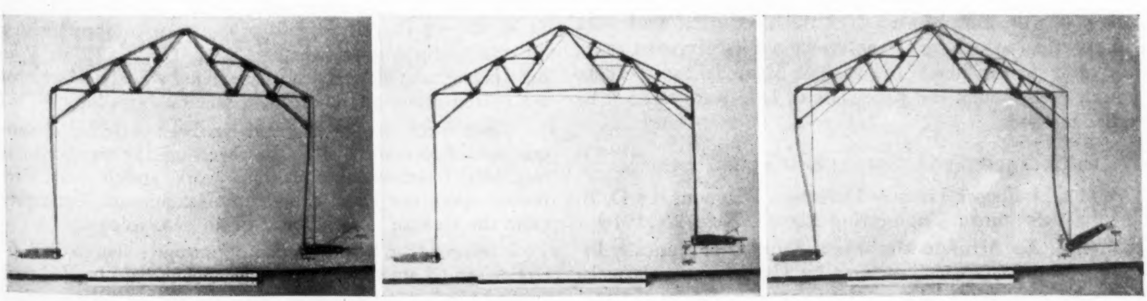
Care must be taken, when a reaction has been deflected, that friction in the model does not restrain free movement. Beggs floats his models on steel balls on glass. Small steel balls placed under a few of the wire model plates permit free movement in the heavier models.

Fig. 8 shows the model of a mill building frame having offset crane girder columns with hinged bases. The mathematical analysis of such a structure is always questionable, due to the abrupt change in the column section. The second deflection of the left horizontal reaction has been made, with the first position shown dashed. The uniform wind load has been separated into three concentrations. After the influence lines have been drawn, the uniform load may be taken as a concentration through such length as the influence line remains a straight line. When the influence line remains a straight line for all practical purposes, the average ordinate is then equal to the mean ordinate through that length. The effect of the offset in the column and change in moment of inertia was obtained by soldering an additional wire to the full length column wire.

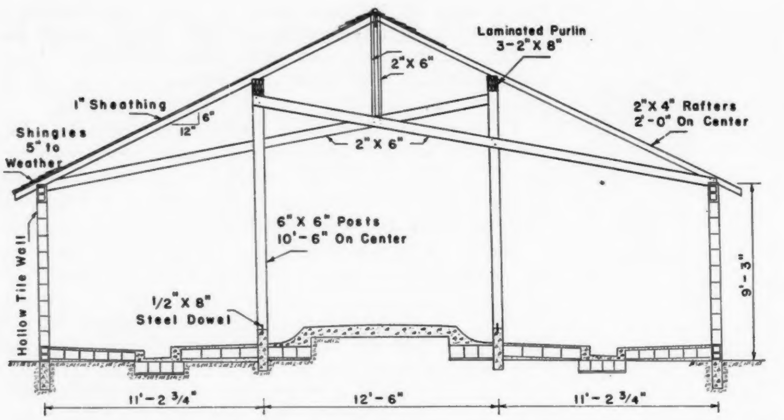
Figs. 9, 10, and 11 illustrate the method of obtaining influence lines from the model of another type of mill building frame, in this case with fixed reactions. Fig. 9 shows the horizontal displacement of the right reaction for horizontal reaction at this point. Fig. 10 shows the right reaction displaced vertically for the vertical reaction. In Fig. 11 rotation has been produced for the moment at this reaction. In measuring the ordinates of these influence lines, ordinates are always taken parallel to the load.

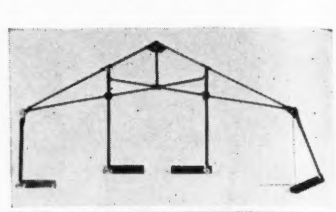
The field of farm structures seems to me to be a particularly fertile territory for the application of models. Many such buildings are designed on the basis of very uncertain assumptions, and would be difficult to analyze by any analytical method. Fig. 12 shows a sectional view of a milking barn having hollow-tile exterior walls, which W. J. Gilmore and I developed as a joint project. Since the hollow tile walls would afford little lateral stability, the model shown in Fig. 13 was constructed with hinged connections where the roof meets the wall, as indicated by the right-hand leg being swung out. This, and several similar models, permitted us to study the relative effectiveness of several plans of cross-bracing in order to obtain adequate later stability.

Fig. 14 shows a model of still another farm structure, a gambrel roof for a barn. In the original, all influence lines were superimposed on the same sheet, each one being shown



FIGS. 9, 10, AND 11 APPLICATION OF FIXED REACTIONS TO MILL BUILDING FRAME MODEL TO OBTAIN INFLUENCE LINES





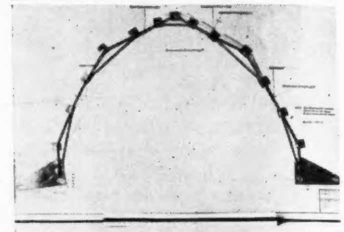


FIG. 12 (LEFT) SECTION OF MILKING BARN. FIG. 13 (UPPER RIGHT) MODEL OF SECTION SHOWN IN FIG. 12. FIG. 14 (LOWER RIGHT) GAMBREL BARN ROOF MODEL UNDER ASSUMED VERTICAL DEAD LOAD AND SNOW LOAD, AND WIND LOAD PERPENDICULAR TO ROOF SURFACE

in a different color. Besides being used to determine reactions for the assumed loads, this model ably demonstrates the weak points of such a roof system.

Results by model analysis, with proper care, compare very favorably with those by analytical method where such can be made. A beginner should start with continuous beams in which he can compare results by other methods and gain confidence in the method. Some engineers do not consider results by model analysis to be accurate enough, although I personally believe these results are more nearly correct than the analytical. When we consider that reactions in the actual structure do not have knife-edge supports, and that assumptions as to modulus of elasticity are possible of variation, it should be evident that even a mathematical solution is not the final word. When knee braces are used, the model analysis is certainly more reliable. Consistent accuracy should be the designer's main criterion.

Since the size of all members must be known before any analysis can be made involving deflections, some assumptions are necessary at the start. My usual method by model analysis is to assume all members of equal size, constructing all parts of the model of the same size wire. The first analysis then becomes an approximation by which the sizes can be revised previous to making a final analysis. The Beggs' method has one advantage here in that a model of cardboard or celluloid may be trimmed down for corrections in member sizes.

The greatest single advantage in favor of the model analysis seems to me to lie in the experience required of the operator. Students can quickly learn to handle complicated structures which would require long experience by any analytical method. On the Illinois Central, we trained one of the draftsmen to do all of the mechanical work with an experienced designer to interpret results. In most cases, the time element makes the analysis by model more economical, even though the same class of help were to do it by other methods.

BIBLIOGRAPHY FOR STRUCTURAL MODEL ANALYSIS

(1) Influence Lines as Deflection Diagrams, by D. B. Steinman. Engineering Record, Nov. 25, 1916

(2) An Accurate Mechanical Solution of Statically Indeterminate Structures by Use of Paper Models, and Special Gages, by George E. Beggs. Journal Am. Conc. Inst., vol. 18, 1922

(3) Mechanical Calculations of Elastic Systems by Otto Gottschalk. Journal of The Franklin Institute, July 1926

(4) Brass Wire Models Used to Solve Indeterminate Structures, by Anders Bull. Eng. News-Record, Dec. 8, 1927.

Equipment to Meet Disease Control Problems

(Continued from page 354)

dously in reduction of the price he would have to pay. Neither is it difficult to appreciate from a glance through almost any sprayer catalog, that most of the so-called special conditions can as readily be met by a standard catalogued outfit as by the slightly different ones so often demanded. Let us, therefore, discourage special equipment unless it is really capable of producing materially better results or lower operating costs.

4 His sprayer is the grower's most important investment, yet from a mechanical standpoint, practically no organized factual data has been published on which he can base his purchase.

I will admit that any agricultural engineering department having the temerity to attempt publishing standards to meet requirements of the great number of conditions under which sprayers are used, would be undertaking a real job. I do believe, however, that our growers who make a sprayer investment on which their crops must depend for ten to fifteen even twenty future years, should have available to them more disinterested advice on whether an outfit of 30-gpm capacity should properly be equipped with a 14 or a 25-hp engine; whether 3/8, 7/16, 1/2, 5/8, or 3/4-in hose is best adapted for general spraying work; and whether a hundred other details are necessary or advisable.

True, much data of this sort has been included in various published reports. It is, however, usually mentioned as incidental to other investigational work, and is usually reported upon, not from a mechanical standpoint, but rather from the view of a pathologist or an entomologist.

I believe that a real service opportunity lies in this direction, and I am certain that a number of bald-headed men around sprayer factories of the country would appreciate the opportunity to cooperate with whoever might attempt it.

Some Observations on the Behavior of Models of Gully Control Structures

By H. B. Roe

THIS PAPER is based on studies carried out in the early spring of 1935 as a result of the experience of the soil erosion control wing of the ECW in Minnesota during the two years just preceding. In a number of instances the gravity section, rubble masonry dams with rectilinear weir crest, used for head control of gullies, had failed because of the undermining and breaking down of their basal aprons. Although I have never been able to find sound authority or justification therefor, the rule in quite general use at that time for length of apron downstream from the base of the dam, was 1½ times the vertical height of the dam above the apron.

Examination of the cases of failure with especial reference to local conditions of approach slope, gully floor gradient, height of weir notch above the apron, and quantity of water to be carried, indicated that the failures were principally due to the fact that the aprons were too short. No effective method seemed to have been worked out for sufficiently stilling the turbulence and dissipating the energy of the falling water, before it passed off the apron, to eliminate the churning action that almost invariably resulted in undermining of the apron, and eventually of the dam itself.

It was, therefore, concluded that a laboratory study of the problem, on models under controlled conditions, would be helpful and should be undertaken. Such a project was set up cooperatively between the division of drainage and waters of the Minnesota Department of Conservation (whose chief, Walter S. Olson, was state director of the ECW in soil erosion control) and the division of agricultural engineering and the department of hydraulics of the University of Minnesota.

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 30, 1938. Approved for publication as Scientific Journal Series Paper No. 1619 of the Minnesota Agricultural Experiment Station.

Author: Professor of agricultural engineering, University of Minnesota. Fellow A.S.A.E.

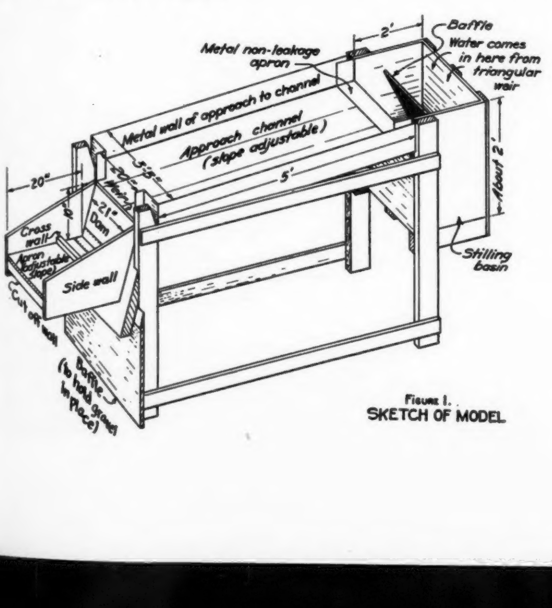


FIGURE 1. SKETCH OF MODEL

The model was designed and constructed by the division of agricultural engineering. The necessary gravel was furnished by the department of hydraulics, which also made available one of the large concrete flumes in the hydraulic laboratory, the water supply, and the various operating and measuring devices needed in the study. The photographic records of the results of tests were furnished by the author.

The tests were carried out under the immediate direction of the author, assisted by J. H. Neal and O. W. Howe of our divisional staff, and L. A. Johnson and R. L. Feffernan of the local engineering staff of ECW. Dr. L. G. Straub, university hydraulician, acted as technical adviser.

The model (Fig. 1) was constructed of wood, on a scale of one inch to the foot. It included the approach to the dam, the dam with the weir, and the apron and side walls below the dam. It stood in a galvanized iron tank 16 ft long, 42 in wide, and 30 in deep. The gully floor consisted of gravel (the screen analysis of which is given in Table 1) placed in this tank ahead of and around the apron.

CONDITIONS OBTAINING IN THE MODEL

In the model the following conditions obtained:

1 *Approach to the dam.* The width was constant at 39 in, or 9½ in each side of weir notch. The slope could be varied from 0 to –10 per cent.

2 *Dam.* The height was kept constant at 10 in below the weir notch. The batter of the outer face was ½ to 1.

3 *Weir notch.* The width was kept constant at 20 in. The sides were vertical.

4 *Apron.* The width was kept constant at 21 in between side walls. The slope could be varied from 0 to –10 per cent.

5 *Gully floor.* The material was gravel, of composition shown in Table 1. The slope could be varied from 0 to –10 per cent.

6 *Cross walls on apron.* Cross walls 1 in thick and from 1 to 3 in high were tried out at various distances from the foot of the dam to determine the height and position of cross wall giving the best results in reducing turbulence of the falling water.

7 *Cut-off wall at toe of apron.* A cut-off wall in one piece with the apron and extending 3 in below the floor was placed across the entire toe of the apron.

TABLE 1. SCREEN ANALYSIS OF GRAVEL USED TO FORM GULLY FLOOR

Mesh of screen retaining	Before tests, per cent	After tests, per cent
4	8.34	8.83
8	70.92	74.13
16	15.40	13.37
30	2.78	2.38
50	1.32	0.85
100	0.73	0.34
Residue	0.51	0.10
Total	100.00	100.00

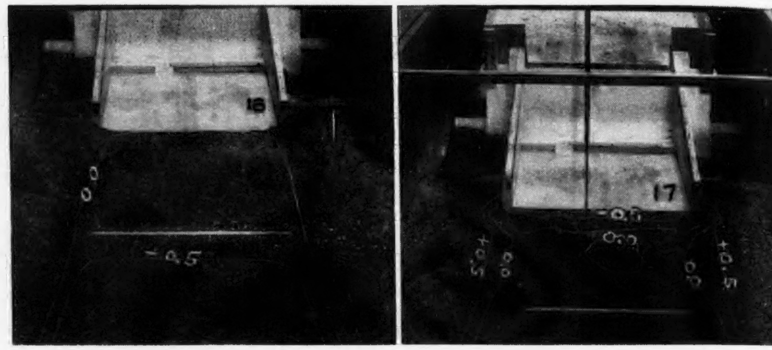


FIG. 2 (LEFT) TYPICAL OF ALL "BEFORE" SET-UPS EXCEPT FOR DIFFERENCES IN CONTOUR INTERVAL HORIZONTALLY. (RIGHT) "AFTER" FOR THIS SET-UP, ONLY.

RELATION GULLY FLOOR TO LOWER END OF APRON FLOOR: Flush but dropping away on a 2 per cent slope

PSEUDO-RIPRAP (Wooden Strip): None

CROSS STRIPS IN GULLY FLOOR: Used. Spacing, 20 in

CONCRETE FRAGMENT RIPRAP: None

BROKEN TILE RIPRAP: None

WATER SUPPLIED, or Q in cfs: 0.173

VELOCITY OF WATER AS IT LEAVES APRON: 2.20 ft/sec

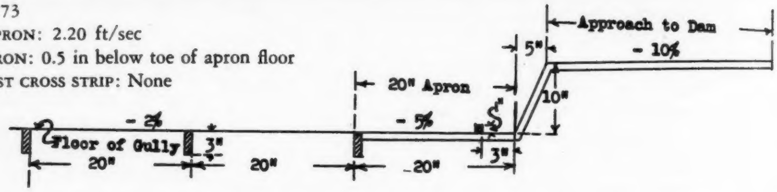
BOTTOM OF PIT IN FRONT OF APRON: 0.5 in below toe of apron floor

BOTTOM OF PIT IN FRONT OF FIRST CROSS STRIP: None

BOTTOM OF PIT IN FRONT OF SECOND CROSS STRIP: None

ADDITIONAL NOTES: Really very little erosive effect anywhere

SERIES NO. E. RUN NO. 14



8 *Cross checks in gully floor.* These were provided as ¾ by 3 or 4-in wooden strips reaching across the gully floor and well into the side banks for anchorage. They could be set at any elevation and spacing desired.

9 *Riprap.* A wooden strip similar to the cross checks and ¾ by 4½ or 4¾ in was frequently used across the end of and adjacent to the apron toe to simulate grouted riprap. In a few cases toward the last, fragments of concrete cylinders or fragments of concrete drain tile were also used below the apron toe and below the cross checks in the gully, to simulate hand-placed riprap without grouting.

PRELIMINARY CONSIDERATIONS

Before these tests were actually started, Field Superintendent Hosmer, at the author's request, made the following suggestions as a sort of guide and limitation for the scope of the tests.

1 *Head on weir notches.* It is desirable to keep to a maximum, so far as possible, of 1.5 in with a weir freeboard of 0.5 in—that is, a depth of weir notch of 2 in.

2 *Breadth of weir notch and apron.* The breadth of the weir notch is usually determined by the width of the head of the gully and especially by the width of the gully floor at the base of the dam, a range of from 4 to 20 in being considered safe for the tests. This also fixed the width of the apron.

3 *Natural gradient of approach to dam.* This varies in general from about 3 to 8 per cent and is usually a solid sod slope.

4 *Overfall at head of gully.* As a rule, in actual cases, this will lie between 4 and 10 ft from crest of weir to apron floor. ECW forces will usually limit their highest structures to 10 ft or under, corresponding to 10 in in the model.

5 *Natural gradient of gully floor.* In nature this would usually lie between 1 and 3 per cent for fairly stable conditions, but it is occasionally steeper and unstable. Such cases as these latter are usually for very small watersheds and relatively new gullies.

GENERAL PLAN OF TESTS

1 *Natural conditions adhered to.* In view of the preliminary considerations cited by Hosmer, and owing partly to the limited time that could be alloted to this work, the entire scheme of tests was held within the limits imposed by the conditions named in the preceding section, that is, approach slopes were held between 2 and 10 per cent. As earlier stated the breadth of weir notch and height of dam were held constant at 20 and 10 in, respectively. The maximum depth of water over the weir crest was held as near 1.5 in as was possible with existing turbulence, and the slope of the gully floor was varied between 0.5 and 10 per cent.

2 *One weir crest and one height of dam.* Owing to the fact that a complete study of this problem would have involved at least 256 series of tests and that the time limit set on this work, so far as ECW assistants was concerned, would permit of only a small percentage of that number, the decision to confine these studies to one height of weir notch above apron and one breadth of weir notch was made on the advice of Dr. Straub. The wisdom of this decision was maintained on the ground that a reasonably thorough solution of the one general setting would enable one to extrapolate with sufficient accuracy for field practice and with reasonable safety to other major cases.

3 *Cross walls tested.* Cross walls of the heights of 1, 1½, 2, 2½, and 3 in were tried out in each principal modification of each major series, at various distances from the foot of the dam, but it definitely appeared, in every case, that a cross wall not to exceed 1 in in height gave the best results. The distance from the foot of the dam, that gave the best results, in each case, in stilling turbulence, for each quantity (Q) of water used, is shown in Table 3.

4 *Water furnished to model.* The amount of water furnished to the model at any time was under definite control and, for each slope of approach used, was so regulated that the maximum depth over the crest of the weir was maintained, as nearly as possible with the turbulence present and the tendency to pile up at one side, at the 1½ in

TABLE 2. GROUPINGS OF PICTORIAL DATA SHEETS

Group number	Per cent slope of approach	Percent slope of apron	Per cent slope of gully floor	Pictorial data sheet numbers
I	10	0, 5, 10	0.5, 2, 5, 10	1 – 19
II	5	2, 5,	0.5, 2, 5, 10	20 – 27
III	2	0, 2,	0.5, 2, 5,	28 – 38

already mentioned. The water was furnished over a carefully calibrated standard triangular weir with a right-angled vertex, so that the amount furnished could be and was carefully measured for each test.

5 *Photographic records of results.* Again on the advice of Dr. Straub, contours of both "before" and "after" gully floor conditions, with ½-in intervals (corresponding in nature to ½ ft) were laid with moistened white cotton twine, and photographs showing the general conditions before the run and, in each major case, after the run, were obtained.

6 *Contour datum plane.* The zero datum of all contours adjacent to the toe of the apron and lying between it and the first cross strip in the gully floor was taken as the level of the apron floor at its toe. The zero datum of all contours lying adjacent to and just downstream from any given cross-strip check in the gully floor was taken as the top of said cross strip. Contours lying above any given datum are marked on the photographs with a plus sign and the proper numeral. Those below a given datum are similarly marked with a minus sign and the proper numeral.

7 *Length of each test run.* Each test was run for 15 min after the flow conditions had become as nearly stabilized as it was evident they were going to be.

TABLE 4. RECOMMENDED LENGTH OF APRON AND LOCATION OF ONE-FOOT CROSS WALL ACROSS APRON FOR DIFFERENT AMOUNTS OF RUNOFF

Rate of run-off in cfs.	Distance, D, in feet, of 1 foot cross wall from foot of dam for heights of dam to weir crest given in feet at heads of columns below				Recommended total length, L, in feet, of apron for heights of dam to weir crest given in feet at heads of columns below			
	4	6	8	10	4	6	8	10
50	2.0	2.5	3.0	3.0	10.0	12.0	14.5	16.5
100	3.0	4.0	4.5	5.0	11.0	13.0	16.0	18.0
150	3.0	4.0	4.5	5.0	12.0	14.5	17.0	19.5
200	3.0	4.0	4.5	5.0	13.0	15.5	18.5	21.0
250	4.0	4.5	5.5	6.0	14.0	17.0	20.0	22.5
300	4.0	5.0	6.0	6.5	14.5	18.0	21.0	24.0
350	4.5	5.5	6.3	7.0	15.5	19.0	22.5	25.5
400	4.5	5.5	6.5	7.0	16.5	20.5	24.0	27.0

TABLE 3. ESSENTIAL VALUES OBTAINED BY MEASUREMENT, OBSERVATION OF THE ACTION OF THE MODEL, AND FROM ANALYSIS OF THE DATA

(All dimensions are in inches except as otherwise noted in the table headings)

Vertical height, *H*, of the dam is 10 in in all cases

Q range used, in cfs: In the model	Corresponding value in the prototype	Distance, foot of dam to cross wall	Range of turbulence from foot of dam	Additional length required on apron	Recommended length, *L*, of apron: In model	In prototype (ft)
0. to 0.173	0 to 86	3.0	10.0	7.5	17.5	17.5
0.173 to 0.226	86 to 113	5.0	12.0	6.0	18.0	18.0
0.226 to 0.244	113 to 122	5.0	12.5	6.0	18.5	18.5
0.244 to 0.336	122 to 168	5.0	14.0	6.0	20.0	20.0
0.336 to 0.376	168 to 188	5.0	14.5	6.0	20.5	20.5
0.376 to 0.498	188 to 248	5.0	16.5	6.0	22.5	22.5
0.498 to 0.639	248 to 316	5.0	18.5	6.0	24.5	24.5
0.639 to 0.761	316 to 380	5.0	20.5	6.0	26.5	26.5

OBSERVATIONS, MEASUREMENTS, AND RECORDS

A complete record was made of all measurements and phenomena that it was thought might be of some value in the analyses. This record consisted principally of 38 pictorial data sheets similar, in general details, to that shown in Fig. 2, but varied in numerous minor details to fit the particular test in each case. As will be observed from a study of Fig. 2, these data sheets are largely self-explanatory, so need not be analyzed in detail herein. For convenience in reference and in analysis of the data in the final report, however, these sheets were arranged, as shown in Table 2, in three major series.

Obviously the great mass of data obtained in the study precludes its being shown in this limited discussion, and the means of publishing the entire report in detail has not been available. However, the complete data are on file for future reference, as may seem necessary or desirable, at University Farm, St. Paul. For the purposes of this paper, Table 3, which is self-explanatory when considered in the light of the foregoing discussion and in conjunction with Fig. 2, gives a condensed view of essential dimensions, observations, and some of the final conclusions reached in connection with the model used.

APPLICATION OF OBSERVATIONS ON THE MODEL TO THE PROTOTYPE AND TO OTHER CASES OF OTHER BASAL DIMENSIONS

1 *Froude's Law governs.* In passing from phenomena that occur in the model to the corresponding probable phenomena in the prototype, in any case in this problem, it is assumed that Froude's Law of Similitude governs without appreciable interference by extraneous influences. Hence:

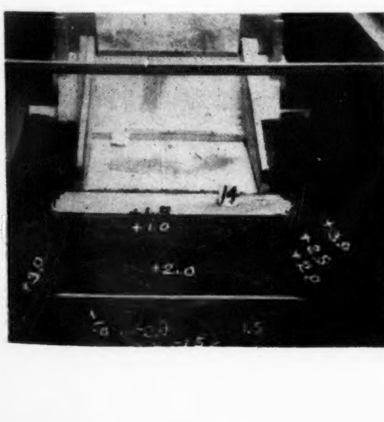
$q = w = l^{5/2}$, and $v = \sqrt{l}$, in which

q is the ratio of corresponding discharges (Q) in cfs

w is the ratio of corresponding weights of water (W) in pounds per cubic foot

v is the ratio of corresponding velocities (V) in feet per second

l is the linear scale ratio between model and prototype.



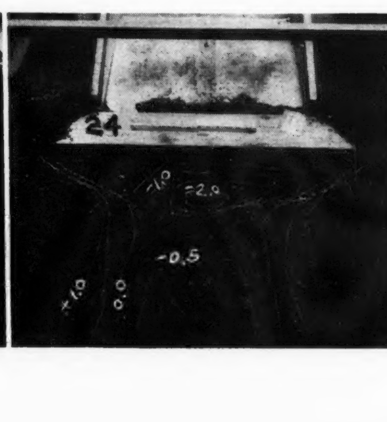
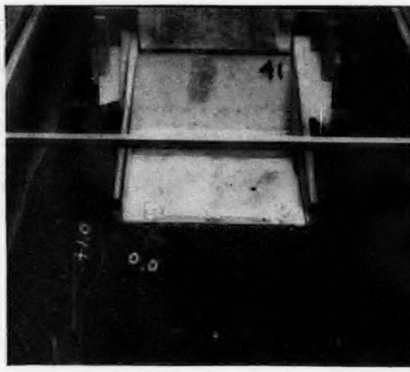


Fig. 3 (Left) Showing the strong combined influence of the 1-in baffle wall across the apron, 3 in from the toe of the dam, and the submergence of the apron toe 1 in below the gully floor, in almost wholly dissipating the energy of the falling water and preventing erosion, even when the gully gradient is no flatter than the apron gradient. Fig. 4 (Right) Showing the disastrous effect of making the apron gradient flatter than the gully floor gradient, even when the cross wall is used on the apron and the apron toe is protected by grouted riprap and submerged 1 in below the floor of the gully. Undermining is sure to occur eventually in this case



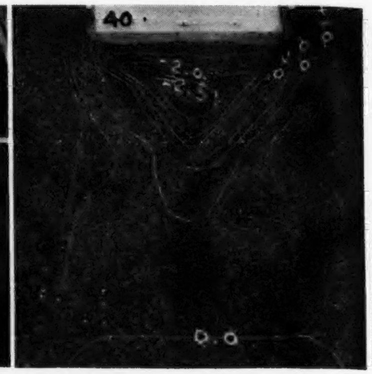


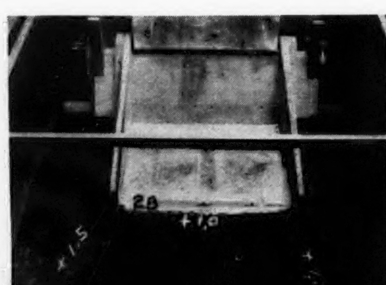
Fig. 5 (Left) Showing the marked combined influence of the 1-in cross wall on the apron, 5 in from the toe of the dam, and of building the apron on a steeper gradient than the floor of the gully. There was no marked difference in appearance in this case between the "before" and the "after" views. Fig. 6 (Right) Showing the serious results of failing either to use the baffle wall across the apron, to submerge the toe of the apron below the floor of the gully, or to construct the apron on a steeper gradient than that of the gully floor

2 *Assumptions used in analysis.* The first of these assumptions is that *the range of the water fall varies as the square root of the height of the dam.* The velocity of approach is sufficiently small so that it may be neglected in considering the range of the falling water; that is, the water, as it moves over the crest of the weir, is considered as moving to its fall from a still basin, hence the range is assumed to vary as the *square root of the height (H)* of the waterfall. This assumption is used in extending to other cases the results from *observed* cases in determining the optimum position of the cross wall on the apron.

The second assumption is that *the range of great turbulence is approximately proportional to the energy of the falling water* and, therefore, to the height (*H*) of the waterfall. This principle is used in connection with the next assumption in extending (Continued on page 364)

TABLE 5. DATA PERTINENT TO FIGS. 3 TO 8, INCLUSIVE

Item	Fig. 3	Fig. 4	Fig. 5	Fig. 6	Fig. 7	Fig. 8
Approach gradient, per cent	10	10	5	5	2	2
Apron gradient, per cent	5	0.0	2	2	2	2
Gully floor gradient, per cent	5	5	0.5	2	2	0.5
Relation of gully floor to apron floor at toe	1 in above	1 in above	Flush	Flush	1 in above	Flush
Pseudo-riprap	Used; 4½ in wide; 1 in above apron toe	Used; 4¾ in wide; 1 in above apron toe	None	None	None	None
Cross strips in gully floor	Used; spaced 20 in	None	None	None	None	None
Water supplied in cfs	0.173	0.173	0.226	0.226	0.244	0.244
Velocity of water as it leaves apron, ft/sec	1.18	1.68	1.74	3.80	1.42	3.88
Depth of pit in front of apron below apron floor, inches	0.3	3.5	No pit	3.4	No pit	3.15
Depth of pit in front of first cross-strip below top of strip, inches	2.1					
Depth of pit in front of second cross-strip below top of strip, inches	0.8					
Additional notes:	Below third cross strip the gravel piled up higher than its first position instead of washing out below the strip	Considerable washing around and under riprap	No serious erosion at toe of apron	Very bad erosion here shows lack of influence of cross wall on apron in preventing same	Erosive action practically negligible here	Very bad pit 13 in ahead of apron toe. Undermining sure to occur here eventually



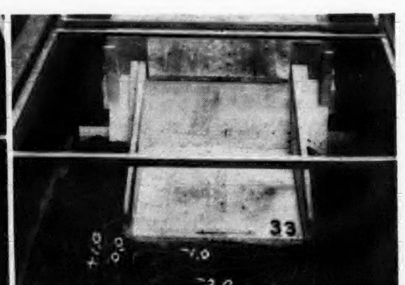


Fig. 7 (Left) Showing the excellent influence of the 1-in baffle wall across the apron, 5 in from the toe of the dam, combined with submergence of the toe of the apron 1 in below the gully floor, even when both are on the same gradient. There was no appreciable difference here between the "before" and the "after" appearance. Fig. 8 (Right) Showing the serious erosion that may occur when no cross baffle is used on the apron and when the apron toe is not submerged below the gully floor even when the gully floor gradient is much flatter than that of the apron. Eventual undermining is sure to occur in this case

Outdoor Brooding of Chicks

By A. R. Wood

ABOUT ten years ago my company started experimenting with radiant-heat electric brooders. With the cooperation of the division of agricultural engineering, University of California, we finally developed a practical and efficient electric brooder. This was quite a departure from the conventional type of electric brooder on the market at the time. It had no curtain around the bottom edge of the hover, and the heat was provided by means of porcelain elements wound with high-temperature resistance wire which heated to a red glow. These elements were mounted in the top of the hover 2 ft above the floor. Above these heating elements was a large copper reflector which was so shaped as to deflect the heat downward toward the floor under the hover. We soon had a number of these brooders in the field and found they gave excellent satisfaction.

As we expanded our sales and more people began to use these brooders, we found that best results were obtained when the brooders were operated in open, well-ventilated rooms. By well-ventilated rooms is meant rooms with the fronts partially or entirely open and with a large opening in the back of the room to provide cross circulation. The opening at the back was arranged in such a way that the incoming air was directed upwards, so as not to create a floor draft.

The chicks brooded in the open rooms did so much better than those in the closed rooms that we emphasized this point repeatedly in all of our literature, and tried to educate our salesmen and dealers to follow up on this feature and insist on it. But here was a serious problem. It seemed impossible to get the poultrymen to ventilate their brooder rooms properly. They had been accustomed to the coal or oil brooder operated in a room as near airtight as they could make it, the purpose being to insure as nearly as possible a uniform temperature throughout the entire room.

Try as we might, we just could not get the poultrymen to realize the importance of ventilation, or what we meant by ventilation. Ventilation of a brooder room to many poultrymen at that time meant opening a small window at one end of the brooder room during the warm part of the day only, or having one or two of the spaces between the rafters and the top wall plate open. Most of them had never heard of brooding in an open-front laying house, and to have the front open and an opening in the back at the same time seemed to them to be courting disaster. We had many users in different localities who did follow out our instructions as to ventilation, with excellent results, but we could not very well ask these people to let us use their brooder houses as demonstration units for that community. Yet we felt that a practical demonstration would be the only way to bring the idea of ventilation forcibly to their attention.

We thought of building a model brooder house near a dealer's feed warehouse, but even the cheapest brooder house would cost more than would be practical to invest in this form of advertising.

We studied the problem further. Here we had an electric brooder which provided a dry, uniform heat over the entire surface of the floor which the canopy covered. The canopy was high enough so that feed and water containers could be put under it and yet provide plenty of space for the chicks. The attraction light kept the space under the brooder light, so the birds could see to eat and drink. They had more space per chick under our electric canopy than under the average battery brooders. Why not try brooding out-of-doors in a wire pen? By using a ring of metal around the outside of the brooder there would be no cross draft. A pen of this kind would be cheap to build, and we could put them in a number of scattered localities without too much outlay and expense.

The first step, of course, was to try out the plan at home, where we could watch it. We constructed a wooden platform measuring about 10x12 ft and enclosed it with screen walls 4 ft high, above which we built a gable roof. We purchased 300 day-old White Leghorn chicks and put them under one of our radiant electric brooders in this enclosure, with feed and water under the hover and a metal ring around it. It was January and the nights were often frosty and the days, when not rainy, were often cloudy and cold. We watched the brooder temperatures carefully and studied the behavior of the chicks, in order to make sure that they were not exposed to too much heat, which would tend to drive them away from the brooder into the cold, and yet provide enough heat to keep them comfortable.

The success of this first outdoor brood was quite beyond our expectations. The mortality was not greater than the average experienced by successful poultrymen brooding under what were generally accepted as ideal conditions. The chicks seemed to show far greater activity than chicks brooded in the regular brooder rooms. They feathered out more rapidly. The growth of the birds during the first two or three weeks appeared to be somewhat slower than that of chicks brooded indoors, yet by the end of the seventh week they had attained about the same size. We kept the heat on these birds 33 days, reducing the temperature about 2 deg F every third day. The most satisfactory starting temperature we found to be about 88 F on the floor, 12 in in from the edge of the canopy.

After the second day we took the feed and water containers out from under the hover and placed them around the outside of the canopy, about a foot or two from the edge.

The idea has long been prevalent among poultrymen that baby chicks cannot stand getting wet. It was thought they would get sick and die. This did not prove to be the case at all in our experience. These chicks got wet practically every day it rained, and it rained on 10 different days during the 33 days we had heat on the birds. We could find no detrimental effects whatsoever to the chicks from their exposure to the rain. At first they spent more time under the brooder during the rainy days, but as they grew older they seemed to pay very little attention to the rain and went outside with utmost freedom.

Our experiment had been conducted under what would be considered severe weather conditions, and it had proved that the idea was practical.

We immediately arranged to make an outdoor installation at Hayward, one at Petaluma, and one at Rio Linda, California. We worked out a simple, inexpensive, wire netting 10x16-ft house. The frame was built entirely of 1x4-in pine. The wire sides were 4 ft high, with a gable

---

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: A. R. Wood Manufacturing Co.

roof 8 ft to the ridge pole. The material for this unit, purchased from any local lumber yard, costs between $15 and $20 and the unit could be built by two men in one day. This unit did not require any floor.

We tried building a few of the units in our factory at Santa Cruz, shipping them knocked down to the locality where they were to be used. This plan proved to be impractical, so we had plans and specifications for the unit drawn and blue prints made, which we could send to our representatives in localities where they wished to put on a demonstration.

When we went into a poultry community to install one of these outdoor units, the poultrymen soon learned of our plans. Some of them would come and remonstrate with us, urging us not to attempt such a foolhardy scheme. We told them that as it had worked in Santa Cruz under severe weather conditions, surely it would work elsewhere. In each instance the answer was that it might work in Santa Cruz, but in this particular locality there was an unusual wind or a freak climatic condition that would preclude any possible success. We went ahead and built the units, installed the brooders, and put 400 chicks under each of them.

The first year we made four outdoor installations in the localities named above. Average mortality of chicks brooded under these outdoor conditions did not exceed 5 per cent. The birds in every case were almost entirely free of the usual diseases and baby chick ills which the average poultryman has to contend with in brooding under hot-room conditions. Careful records were kept of the livability of the birds during the following two years. In each instance the mortality of the birds was much lower than that of birds brooded in hot rooms.

The chicks from one of these outdoor broods were used in a large experimental plant where feed formulas are developed and tried. At the same time, chicks from the same stock and of the same age, which had been brooded under hot-room conditions, were put in the experimental pens in this same plant. At the end of the first year the total mortality of the flock from the outdoor brooder was 13 per cent; the mortality of the flock brooded in the hot room was 37 per cent. The latter figure had been a fair average of their mortality in years past, on flocks brooded under hot-room conditions. Today, the management of this establishment sees to it that the chicks used for experimental feed tests are brooded in cold rooms or in open air.

The following season we made arrangements for installing twelve of these outdoor broods, scattered from as far north as Everett, Washington, to as far south as San Diego, California. By this time we had learned the technique of outdoor brooding, so that we could be reasonably sure of good results. Accurate records were kept of current consumption, daily outdoor temperatures, weather conditions, weights of chicks, and amount of feed consumed. Outdoor brooding, as it was conducted in these units, was successful beyond any question. And above all, we got our idea of ventilation across to the poultryman.

All told, there have been some forty of these outdoor broods raised with our brooders. They have been operated, in most instances, during the winter months. Average consumption of electric energy has been about 500 kwh. The average number of days the heat was required was about 35. Any good commercial feed proved satisfactory and a variety of commercial feeds were used, apparently with equally good results.

We do not advocate brooding out-of-doors for the commercial poultryman. We merely used these demonstrations to show that chicks lived, grew, and developed into healthy profitable pullets when they had a lot of fresh air, and that there was no danger of getting too much fresh air. A light, clean, open-front house, with a good air intake at the back, will give equally good results and will not expose the chicks unnecessarily to severe weather hazards.

Some Observations on the Behavior of Models of Gully Control Structures

(Continued from page 362)

the observations on the cases tested to other and practical cases, to determine the proper length of apron.

The third assumption is that a *fairly constant additional length of apron beyond the range of turbulence is needed in all cases,* namely about 6 in (corresponding to 6 ft in the prototype). This seemed verified by the fact that the assumption resulted in a straight line relationship between the total discharge and the total length of apron needed to give best results in every case.

Table 4, which is the same as Table 7 of Minnesota Special Bulletin 171, was prepared on the basis of the immediately foregoing discussion.

Figs. 2 to 8, selected from the 45 photographic records secured, together with explanatory legends thereunder and in conjunction with Table 5, giving the test and observational data relative to each of these seven pictures, all as illustrative of typical cases, will be found helpful toward a fuller understanding of the study and of the conclusions reached and of the recommendations hereinafter offered.

CONCLUSIONS AND RECOMMENDATIONS

1 Gully floors with gradients of 3 per cent or more are usually unstable. Such require cross check dams at intervals that will reduce the gradient to 2 per cent or less. Heavy hand-placed riprap, with its surface lying within the new stabilized gradient, is needed below each check for a width of 6 to 8 ft. The crest of the first check below the apron should be at practically the same elevation as that of the apron toe.

2 The apron gradient should be steeper than that of the gully floor where the gully floor gradient exceeds 2 per cent. The apron gradient should *never* be flatter than the gully floor gradient. Submerging the toe of the apron 1 ft below the gully floor is desirable. The cut-off wall at the toe of the apron should extend at least 3 ft below the apron floor at the toe.

3 The apron length, in each case, should be at least as great as that recommended in Table 3.

4 There should be a cross wall 1 ft high, across the apron to dissipate the energy of the falling water, and, in each case, this cross wall should be located at the distance from the foot of the dam shown in Table 4.

5 The side or buttress walls along the sides of the apron should be turned at right angles at the lower end and run well into the natural walls of the gully.

6 Heavy hand-placed riprap, for a width of 6 to 8 ft, and laid on the gully floor gradient and flush with the apron floor at its toe, is desirable and even essential with large amounts of water.

FURTHER STUDY NEEDED

Further experimentation extending through a considerable period of time, and done in unhurried manner, is needed for the proper solution of this important and far-reaching problem.

What Agricultural Engineers Are Doing

Contributions Invited

All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

FROM THE U. S. BUREAU OF AGRICULTURAL ENGINEERING

A STUDY of the physical reactions of soil to moldboard surfaces made by I. F. Reed shows that the theory of reaction previously advanced does not hold for broad-base plows or for extremely mellow soil conditions, as the primary shear planes do not extend entirely across the furrow slice. The section next to the shin acts as a chisel and the reaction described takes place only in the remainder of the slice.

* * *

John W. Randolph reported at Washington, D. C., July 8 to take up his new duties in connection with the project on utilization and cost of farm power and machinery. Enroute he inspected the cotton planting tests conducted in cooperation with the Farm Security Administration in north Alabama. Favorable contrasting results in cotton stands were found for the Bureau's variable-depth system of planting.

* * *

E. D. Gordon has found certain variable force relationships in studies of a disk blade held in a fixed position in the different soils at the Farm Tillage Machinery Laboratory. On the soils with a low colloid content and other soils with low moisture conditions and in an uncemented state, the factor of draft increases with speed. The data form a uniform curve. In heavy clay soils in a moist condition there is a fluctuating relationship between draft and speed. At the low speeds the draft increases very rapidly because of the sticking of the soil to the disk causing the sliding of soil on soil. At intermediate speeds the adhesive power of the soil is broken down and there is a marked lowering of the draft due to the sliding of the soil over the disk surface. At the higher range of speeds the draft mounts as the forces set up tend to overcome the cohesive strength of the soil and throw it excessively from the disk. The minimum speed causing a uniform smooth flow of the soil over the disk without need of the scraper gives the lowest draft figure. Furthermore the reactions of the soil on the disk are notably affected by the horizontal and vertical angles of disk setting, by the amount of bearing, and by the concavity and diameter of the disk.

* * *

Planting operations for two fertilizer-placement experiments with celery on muck at Ontario, N. Y., were completed June 29, by L. G. Schoenleber and D. B. Eldredge. A self-propelled, self-guiding, two-row transplanter was equipped in the Bureau with special fertilizer equipment for this work. Celery is one of the crops most heavily fertilized. In 1937 the yield from 1,000 lb of fertilizer per acre placed in a band at each side of the row equalled the yield from 2,000 lb of fertilizer applied broadcast, which is the common farm practice.

* * *

G. A. Cumings inspected fertilizer placement experiments in Maryland, Delaware, and Virginia and conferred with officials of the Virginia Truck Experiment Station July 7 and 8. The experiments with tomatoes include treatments in which a small amount of nutrient solution is applied around the seedling roots with the transplanter water, in addition to the usual fertilizer application. The effects of the nutrient solution to date have been a more rapid recovery of the transplanted seedlings and a more rapid early growth of the plants.

* * *

R. M. Merrill returned to Toledo July 5 from the A.S.A.E. meeting at Asilomar where he presented a paper, entitled "Use of Vapor Spray in Plant Disease Control." While in the West he contacted entomologists and others interested in pest control and pest control equipment. Mr. Merrill left Toledo late this month for Auburn, Ala., to take up his new duties as leader of the cotton production machinery project, which includes the farm tillage machinery activities.

* * *

The annual inspection of the many cement and concrete specimens immersed in Medicine Lake, South Dakota, was held on July 14. Medicine Lake is an ideal laboratory for testing the resistant qualities of cement, for its waters contain about 14 per cent of sulphates and are so corrosive that non-resistant concretes are completely disintegrated within a few months after submergence. D. G. Miller, in charge of the work, reports tests of 158 brands of portland cements from 103 mills of the United States, Canada, and Europe. The results of this work are developing methods of making concrete drain tile that are highly resistant to soil alkali and acid conditions. The investigations are attracting nationwide interest from cement manufacturers and other interested parties.

* * *

An electric power line and electric drainage pumping unit are being installed by E. G. Brown of the Houma station at the sugar-cane drainage experimental project on the Crescent Farm Plantation. The installation will provide automatic control for pumping drainage water from the variable-depth, open-ditch, and tile-drained project areas. The drainage experiments are to determine the effect of various drainage methods upon production of sugar cane.

* * *

The data from the strawberry irrigation experiment at Willard, N. C., compiled by F. E. Staebner, in charge of supplemental irrigation projects, show that irrigation during dry spells on top of a growing season rainfall of over 30 in in each of the last three years has averaged to increase the yield of fruit picked from plots that were irrigated to the extent of 6 in or more during the season, by about 1,000 quarts per acre. Some scattered increases of greater quantities of fruit were obtained by the addition of more water.

* * *

Analysis of the rainfall runoff data collected in the Ralston Creek drainage basin, Iowa, is being attempted in a detail not previously accomplished, so far as is known, for any drainage area. R. D. Marsden has just returned from a 10-weeks study at Iowa City, in cooperation with the Iowa Institute of Hydraulic Research, of the data, the district, and methods of approach. In this drainage basin, comprising 3 sq mi of rolling topography, half in cultivated crops, precipitation records have been obtained with standard and recording rain gages and runoff records with a waterstage recorder, continuously since 1924. Groundwater fluctuations also have been observed. The study is designed to discover how the runoff which is residual rather than a proportion of precipitation, is affected in time and amount by evaporation, transpiration, and soil condition, as well as by rainfall amount and distribution. Determination of the "opportunity" for evaporation and for transpiration, which is dependent upon the amount and distribution of soil moisture, is a major problem of the analysis. Air temperatures, crop growth, and such soil characteristics as permeability and capillarity are important influences to be considered.

* * *

Central District drainage camps during the last fiscal year ending June 30, completed 62,425,000 sq yd of clearing, 16,621,000 cu yd of excavation and embankment, 337,000 lin ft of tile reconditioning, structural, and other work, with an estimated commercial value of $4,980,000. In doing this work 899,589 man-days were

Authors

Hal F. Eier and *Harold E. Stover* are joint authors of "Terracing to Control Erosion", Kansas State College Extension Bulletin 70 revised.

J. B. Kelley and *Earl G. Welch* are two of the authors of "Electric Service for the Farmstead," University of Kentucky Extension Circular No. 311.

Frank B. Lanham edited "Research at the College of Agriculture, The University of Georgia", the annual report of research and investigational activities of the College for the fiscal year ending June 30, 1938. Agricultural engineering contributors to the report include *F. W. Peikert* on "A Low Cost Machine for Harvesting Crimson Clover Seed", *Frank B. Lanham*, joint author on "A Study of Grain Sorghum," *W. N. Danner*, joint author on "Experiments on Soil Erosion Control", *H. E. Lacy* on "A Study of the Pumping Capacity of an Eight-Foot Windmill", and joint author of "Sweet Potato Storage", and *J. W. Simons* and *Frank B. Lanham*, joint authors of "Farm House Research".

used and $995,000 furnished by the drainage enterprises cooperating. During the period July through December, 1937, seven camps were discontinued, leaving in operation at the present date 7 in Ohio, 6 in Indiana, 5 in Illinois, 5 in Iowa, 4 in Missouri and 2 in Kentucky.

* * *

M. G. Cropsey has been transferred from the Washington Office to Fargo, N. Dak., to take charge of the wheat storage studies at that point.

* * *

J. R. McCalmont has just returned from Beemerville, N. J., where cooperative silo pressure studies are being conducted with the New Jersey Experiment Station. A 12x43-ft silo was filled with alfalfa and molasses silage. The pressures are being taken on this silo to compare with other silos filled with the same type of silage and corn silage. Tests recently made in an 18x42-ft silo show that pressures of hay and molasses silage were approximately twice as great as that with corn silage.

* * *

The early part of July J. E. Miller, chief of the division of plans and service, made an inspection trip to Coshocton, Ohio, for the Soil Conservation Service, where a contract was recently let for the construction of five new buildings.

* * *

Following the meeting of the American Society of Agricultural Engineers at Asilomar, Pacific Grove, Calif., which closed June 30, O. W. Meier, utilization division, Rural Electrification Administration, and S. P. Lyle visited the state extension offices at Berkeley, Calif.; Corvallis, Ore.; Pullman, Wash.; Moscow, Idaho; Bozeman, Mont., and a few R.E.A. projects in these states, to further the cooperation between the extension service and the Rural Electrification Administration in aiding farmers to make the best usage of electricity. In addition to the states visited jointly, Mr. Meier visited the extension offices at Laramie, Wyo., and Fort Collins, Colo., and Mr. Lyle visited the extension office at Fargo, N. D., before returning to Washington, D. C. on July 17.

* * *

Fred C. Scobey began the collection of data for a publication on the "Life of Materials of Construction Used on Irrigation Systems." On nearly all of the smaller irrigation enterprises, more or less replacement will be necessary in the next few years. It is the purpose of this study to develop (1) Factors affecting the life of structures under various conditions; (2) the life expectance that can be anticipated if the structure is operated under specified conditions; (3) causes of failures of structures other than a normal life span, with suggested remedies for such failures; (4) the alternatives, in the way of choice of materials, open to the enterprises in the improvement or replacement of structures. (For example, inverted siphon pipes are the most costly units on many systems in the Northwest. The untreated fir used in the original construction may be repeated, or several other possibilities are available—redwood, creosote-treated fir, concrete, or steel. Each of these has its good and bad points under any given conditions of operation.) Until recent years there was not enough data obtainable for many materials in common use to provide a basis for determination of life expectance, but the time has now come when records covering a sufficient period of years are available for such determination.

* * *

M. R. Lewis spent the first part of the month in the Northern Great Plains area. In North Dakota tentative plans were completed for a cooperative study of the duty of water under irrigation, the North Dakota Agricultural Experiment Station to furnish a full-time irrigation engineer (subject to the appropriation of the necessary funds by the state legislature); the division of irrigation to furnish technical supervision approximately on the basis of one-half time of an engineer; the division of dry land agriculture, Bureau of Plant Industry, to furnish office and laboratory facilities; the North Dakota State Water Conservation Commission to furnish the necessary pumping and irrigation equipment; and the Training School to furnish land, labor, and farm equipment.

* * *

Mr. Lewis, accompanied by Carl Rohwer, visited several projects of the North Dakota Water Commission in the southwestern part of the state. In the James River Valley in the south central part of the state, an area of shallow ground water was inspected. Discussion with local farmers and a well driller, and inspection of a Forest Service nursery well and pumping outfit led to the belief that an opportunity exists for considerable supplementary irrigation from wells in an area of 50 to 100 sq mi, extending into South Dakota.

* * *

A. A. Young initiated evaporation tests of salt solutions at the Fullerton, Calif., station, the solutions ranging from 5 to 25 per cent. Comparisons are made with evaporation from fresh water. Evaporation is less with the higher concentrations although the water temperatures are higher.

A Summer School in Industry

WITH the cooperation of five of the leading manufacturers of farm equipment, a picked group of students and instructors in agricultural engineering at land-grant colleges and universities will have the opportunity next month of attending a five-day intensive course in farm machinery. The activity is being sponsored by the College Division of the American Society of Agricultural Engineers.

The group will spend one day at the main factories of each of the five companies, and beginning with the early development phases of a machine, the first day will be devoted to a study of design procedure and the production of an experimental unit. The second day will be given over to a consideration of the production of machines, including the machines used in production and the assembly line.

The third day will be devoted to the business side of production, including advertising, sales, service, transportation, etc., and the fourth and fifth days will be a continuation of the study of factory production, giving special attention to phases not covered the first day.

A.S.A.E. GROUP AT ASILOMAR

THE PICTURE ON THIS AND THE OPPOSITE PAGE SHOWS A.S.A.E. MEMBERS, MEMBERS OF THEIR FAMILIES, AND GUESTS OF THE SOCIETY IN ATTENDANCE AT THE ANNUAL MEETING AT ASILOMAR, PACIFIC GROVE, CALIF., IN JUNE

NEWS

Washington News Letter

from American Engineering Council

PROCEEDINGS OF THE PHILADELPHIA FORUM

A PRINTED supplement forms the major part of this Bulletin, containing the addresses and digest of discussion on the first public forum held in Philadelphia, May 13, 1938 in cooperation with the Engineers' Relation to It. Extra copies of this contribution to a wider public understanding of the interrelation between technology and employment may be obtained for fifteen cents apiece, from American Engineering Council, Washington, D. C.

The second public forum is planned to be held in Detroit early in November. The exact date and subject will be announced in the August Bulletin. The third forum will be held in Washington the second week in January, 1939 as a part of the Annual Meeting of the Assembly of Council.

SUMMARY OF NATIONAL LEGISLATION

From time to time during the sessions of Congress, there have been reported in this Bulletin, digests of national legislation in which engineers have a special public interest. The staff has prepared a condensed summary of the actions of Congress, both for the special session, November 15-December 21, 1937, and the regular session, January 3 to June 16, 1938. While prepared primarily for members of the committee on public affairs and other special and standing committees, a copy of this summary will be mailed to any reader of the Bulletin, upon request. The review and summary include a statement of the major laws passed, rejected or not acted upon, under the following headings: Communication and transportation, construction, emergency relief, finance, governmental control of industry, national defense, development of natural resources, government personnel, research and standardization, general and miscellaneous.

REPORT OF ANNUAL ASSEMBLY AVAILABLE

The January Bulletin contained a condensed account of the Annual Meeting of the Assembly of the American Engineering Council held in Washington, January 14-15, 1938. The edited stenographic report of the meeting is now available. It will be mailed to each of the delegates attending the session. A limited number of additional copies have been prepared and will be mailed on request to readers of the Bulletin. Additional copies of the proceedings of the Conference of Secretaries of Engineering Societies are also available upon request.

FEES FOR PROFESSIONAL SERVICES

As announced in the May Bulletin, staff investigation of an earlier report that the U. S. Housing Authority was planning drastically to reduce the scale of fees recommended to be paid by local housing authorities, revealed the fact that U. S. Housing Authority officials were actually in favor of increasing the fees by allowances for supervision by engineers of engineering services. The schedule of fees recommended by the U. S. Housing Authority is contained in a brief report of the several conferences between representatives of professional engineering societies called in to conference through American Engineering Council with the American Institute of Architects, at the request of the U. S. Housing Authority.

PROBLEMS OF A CHANGING POPULATION

According to a 300-page report just issued by the committee on population problems to the National Resources Committee (Price 75c), the United States will reach its population peak within 50 years, with a maximum of approximately 158 millions. After this peak is reached, according to the report, unless growth is accelerated by a changed immigration policy, a period of slow population decrease is predicted. The report further states that the signs of change in population trends are already apparent. The rate of growth during the depression was only half of that which occurred during the decade of 1920 to 1930. The committee on population problems sees no cause for alarm in this impending cessation of population growth, but suggests that the anticipated trend during the next half century may offer an opportunity for working out better human relations.

The most striking feature of the population shift predicted is the increase in the number of older workers relative to the number of younger adults. Between 1935 and 1975, the estimated increase in the number of persons 20 to 44 years of age amounts to only 6 per cent whereas an increase of 69 per cent is expected in the number of persons 45 to 64 years of age. An analysis of the age distribution of workers in different industries shows that occupations which have been declining keep their older workers but that the personnel of new industries is heavily weighted with young people.

From an engineering viewpoint the foreword of the report itself quotes from an earlier study of the National Resources Board on National Planning and Public Works in Relation to Natural Resources, which was dated December 1, 1934. The following two paragraphs are quoted:

"The problems centering around land and water cannot be solved in these terms alone, but require for their practical and successful treatment a full consideration of the broader but closely related aspects of agriculture, industry, labor, transportation, communication, health, education, public finance, and government organization.

"Finally, human resources and human values are more significant than the land, water, and minerals on which men are dependent. The application of engineering and technological knowledge to the reorganization of the natural resources of the nation is not an end in itself, but is to be conceived as a means of progressively decreasing the burdens imposed upon labor, raising the standard of living, and enhancing the wellbeing of the masses of the

people. It follows that the social directives back of such technical programs should be developed by persons competent by training and point of view to appraise the human values involved."

THE ECONOMIC STATUS OF THE ENGINEER

Dr. Royal W. Sorensen, professor of electrical engineering at California Institute of Technology, presented a Summary of The Economic Status of the Engineer, at the Summer Meeting of the American Institute of Electrical Engineers, held in Washington, D. C. Dr. Sorensen gives credit to the several bulletins on Sources of Engineering Income, 1929-1934, prepared by the Bureau of Labor Statistics at the request of and with the cooperation of a special committee of American Engineering Council. He briefs his conclusions as follows:

"Engineers, though suffering considerable loss of income and employment during the recent years of business depression, on the whole have fared much better than most classification groups, be they government, capital, profession, or labor.

"Preceding the depression, there was no lack of employment for engineers and their compensation for the most part was equitable in comparison with the pay for other types of service.

"The verdict of users of engineering service regarding the reasons why engineers who have not made satisfactory progress professionally or in their economic status is almost unanimous that such failures are due to deficiencies in personality, general culture, tact, industry, etc., rather than for lack of technical training.

"Graduation from college is prerequisite to success in engineering, but does not *per se* guarantee an engineer.

"The education obtained by taking engineering courses and engaging in the practice of engineering for most of those who have chosen the routes thereof has led to 'the more abundant life' and a better economic status than the lots of the families from which engineers have come."

RESPONSIBILITIES OF THE ENGINEER CITIZEN

Dr. Roy V. Wright, past president of American Society of Mechanical Engineers, and Mrs. Wright have recently published, in collaboration, a most interesting volume entitled, "Responsibilities of the Engineer Citizen." Based in part on Dr. Wright's lectures at the Newark College of Engineering and in part on the personal experiences and activities of Dr. and Mrs. Wright in fulfilling their duties as citizens of New Jersey and of the nation, the book gains added interest as a human document. Short chapters, well displayed, make it especially readable and for those who are students of the questions of citizenship, the volume gains by the addition of a very complete bibliograph.

A.S.A.E. North Atlantic Section Meeting

THE NORTH Atlantic Section of the American Society of Agricultural Engineers will hold its usual yearly meeting, September 20 to 22, at the Parker House, Boston, Mass.

The officers of the Section announce a program that should prove of outstanding interest to agricultural engineers and includes the following subjects: What's an agricultural engineer, selling kilowatts on the farm, engineering for one-story barns, light on the farm of tomorrow, refrigerated locker storages, wall construction for air conditioned homes and refrigerated storages, putting photography to work, grass silage, putting fertilizer where it belongs, white man farming (continued), the low cost automotive type tractor, the binder or combine, how to educate rural youth. In addition there will be three full round-table programs, field trips the afternoon of the last day, and a special program for the ladies.

A.S.A.E. Wheel Project Making Good Progress

ACTIVE field work on the A.S.A.E. project on Pneumatic Transport Wheels for Agricultural Equipment has been in progress since the middle of June. The tires being used are shown in the accompanying illustration. These tires range in cross section from 4 to 12.75 inches and in nominal outside diameter from 16 to 58 inches. Comparative trials of steel rim wheels of comparable dimensions are also being made.

Most of the trials have been made on loose tilled soil, grain, stubble, and blue grass sod, with a few on cinder roads. Volume weight, penetration, and moisture determinations are being made for each set of trials for the purpose of recording accurately the operating conditions.

To date over 800 trials have been made and the results tabulated and partially analyzed. Although field work will be continued during August, emphasis will be placed on the analysis and interpretation of data and preliminary statements with regard to certain phases of the problem should be ready for publication at the time of the fall meeting of the American Society of Agricultural Engineers at Chicago the week following Thanksgiving.

Col. Zimmerman Joins University of California Staff

COL. O. B. ZIMMERMAN, a past president and Honorary Member of the American Society of Agricultural Engineers, has recently joined the staff of the division of agricultural engineering of the University of California at Davis. As research associate in the agricultural experiment station, Col. Zimmerman will be detailed for work in connection with the investigation of sugar beet harvesting machinery, the United Sugar Beet Association having granted $70,000 to support a three-year research program in that field. Col. Zimmerman was for many years connected with the engineering department of the International Harvester Company on developments and standardization projects.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

W. D. Blizzard, 334 Cleveland St., New Albany, Miss.

A. L. Burkett, Box 2, College Station, Tex.

Reuben R. Garrard, Soil Conservation Service, U. S. Department of Agriculture, Washington, Ga.

Walter W. Hinz, Soil Conservation Service, U. S. Department of Agriculture, Ellensburg, Wash.

Robert R. Jamison, manager of sales and development, Esco Cabinet Co., West Chester, Pa. (Mail) 309 N. Franklin St.

David E. Jones, Inverness, Miss.

L. G. Keeney, chief inspector, Farmers Mutual Reinsurance Association, Grinnell, Iowa. (Mail) 814 Fourth Ave.

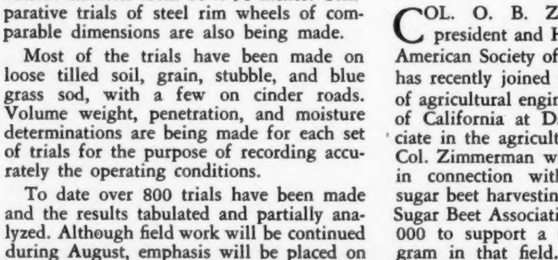
Leon Pearlman, 632 Farrington Ave., St. Paul, Minn.

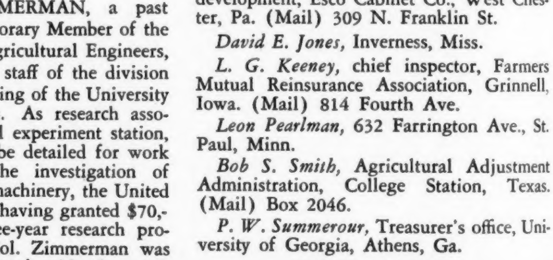
Bob S. Smith, Agricultural Adjustment Administration, College Station, Texas. (Mail) Box 2046.

P. W. Summerour, Treasurer's office, University of Georgia, Athens, Ga.

TRANSFER OF GRADE

Cecil A. Root, supervisor, rural and home service, Northwestern Electric Company, Vancouver, Wash. (Assoc. Mem. to Mem.)





(LEFT) THE TESTING APPARATUS USED AT THE IOWA AGRICULTURAL EXPERIMENT STATION TO MEASURE THE ROLLING RESISTANCE OF WHEELS HAS BEEN CHANGED AND IMPROVED FOR THE WORK OF THE A.S.A.E. RESEARCH PROJECT ON PNEUMATIC TIRES FOR AGRICULTURAL TRANSPORT WHEELS. (RIGHT) AN ASSEMBLY OF THE PNEUMATIC TIRES TO BE USED IN THE TRANSPORT WHEEL TESTS

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, principal agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

EXPERIMENTS ON THE ILLUMINATION OF SEED BY LIGHT OF DIFFERENT WAVELENGTHS [trans. title], *A. A. Kuzmenko*. Compt. Rend. (Dok.) Acad. Sci. U. R. S. S., n. ser., 14 (1937), No. 4, pp. 227-230, figs. 3. Seed of wheat *(Tr[iticum] vulgare and T. durum), Perilla ocymoides, Nicotiana rustica,* and tobacco were exposed during germination to light of different wavelengths or to darkness for 10-15 days and then transplanted to pots, where their growth was observed under natural light conditions. Growth of wheat was accelerated in the range of red-yellow, and its height and total weight were increased. Blooming of *Perilla* was hastened in this range. A marked increase in growth occurred in tobacco treated with red-yellow light, but a retardation with blue light. The amount of nicotine was also influenced by the wavelengths applied to the seed.

STUDIES ON SOIL STRUCTURE: SOME PHYSICAL CHARACTERISTICS OF PUDDLED SOILS, *W. T. McGeorge*. Arizona Sta. Tech. Bul. 67 (1937), pp. 127-177, figs. 8. The author reports a detailed and exhaustive study of the course and result of the puddling process in soils, presenting in tabular and graphic forms experimental results and conclusions. The phases of the subject experimentally dealt with were mechanical methods of analysis, including comparison of mechanical methods, effect of pretreatment with hydrochloric acid, composition of soil separates, dispersing agents, and effect of time on dispersion; puddling ratio as measured by percentage of suspended solids, including, with other work, the effect of boiling at reduced pressure and the effect of replaceable bases upon the puddling ratio; structural stability and settling volume; percentage of soil colloids as determined by water adsorption; and determinations of the percentage of aggregates.

"As we approached the moisture equivalent the soil became increasingly sticky, reaching a maximum state of puddling at a moisture content closely approximating the moisture equivalent. Beyond this critical moisture content the soils became less puddled as we proceeded from the liquid in solid, or plastic, state to the solid in liquid, or fluidity, state. That is, the puddling decreased beyond the moisture equivalent, and the only mechanical effect noted on working with an excess of water was a dispersion or break-down of the crumb structure. . . . .

"As applied to our soils it was found that the per cent soil particles remaining in suspension at an arbitrary time interval was closely related to the amount of moisture present in the soil when it is mechanically worked by a method designed to produce puddling. The maximum percentage of suspended solids is shown when the soil is worked at a moisture content closely approximating the moisture equivalent. Since this value may be greater than that obtained by completely dispersing the soil in a dispersion cup with NaOH, we were led to conclude that puddling and dispersion are radically different phenomena. This study further suggested that the ratio between the percentage of suspended solids in a completely dispersed soil and the percentage of suspended solids obtained under any other condition may be used to express the degree of puddling."

A SIMPLIFIED METHOD OF CONSTRUCTING MERCHANTABLE BOARD-FOOT VOLUME TABLES, *R. H. Blythe, Jr.* Jour. Agr. Res. [U. S.], 55 (1937), No. 3, pp. 159-173, figs. 7. A simple method of constructing volume tables showing the merchantable volume of trees in board feet is presented, which gives a better estimate of the truly merchantable contents than former tables because it takes into account the fact that the upper limit of merchantability is usually fixed by the presence of large limbs or deformities of the bole rather than by minimum diameter. Only four measurements on each sample tree are needed, and 100 trees or less are usually sufficient. The method consists of a basic set of curves of volume over diameter breast high (inside bark) which are modified by two factors, a measure of butt swell and a measure of form or taper. One variation of the method eliminates all need for curve fitting, either mathematical or freehand; thus from one set of data all workers would produce identical tables.

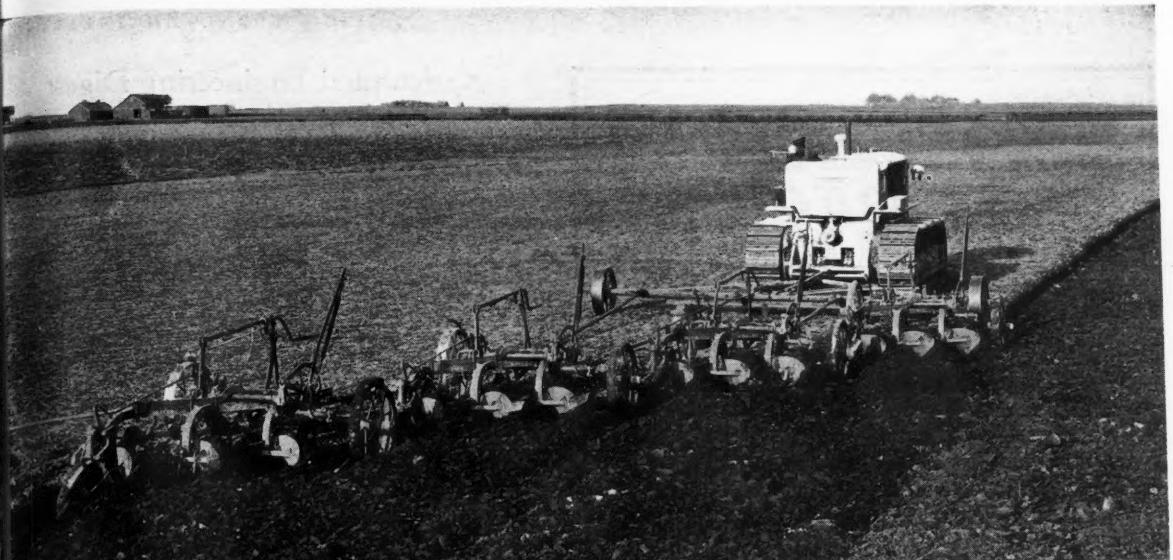
THE RELATION OF WASHING OPERATIONS TO BRUISING AND KEEPING QUALITY OF MCINTOSH AND NORTHERN SPY APPLES, *R. E. Marshall*. Michigan Sta. Quart. Bul., 20 (1937), No. 1, pp. 34-42, fig. 1. Sample lots of McIntosh and Northern Spy apples obtained from growers and packing houses at three stages, (1) upon delivery to the packing house, (2) after washing, and (3) after washing, grading, sizing, and packing, were brought to East Lansing and placed in cold storage. Observations at the time of collection indicated that the personal factor in handling fruit is of great importance in respect to the amount of bruising during the washing process. Padding of the wood in the washers with sponge rubber at points where apples drop or roll is advised. In general, both prewashing and postwashing operations caused more bruising on both varieties than did the actual washing process. Washing practices did not affect the rate of softening, rate of decay, or rate of moisture loss in storage, nor did they affect the rate of moisture loss in apples subsequent to their removal from storage. Large Northern Spy apples (3.5 in in diameter) in the 1936 crop were more susceptible to physiological break-down or decay than were the smaller apples.

EFFECT OF DELAY IN STORAGE AND STORAGE TEMPERATURE ON THE KEEPING QUALITIES OF APPLES, *E. J. Rasmussen*. New Hampshire Sta. Tech. Bul. 67 (1937), pp. 55, figs. 11. With the aid of automatically controlled storage equipment which enabled the maintenance of temperature at desired points, the author established certain facts as to the keeping of Baldwin, McIntosh, and Cortland apples. Firmness of flesh, the skin removed, was found the most effective measure of changes during ripening in storage. Temperature was one of the important factors influencing keeping quality, but temperatures that maintained firmness were not necessarily most desirable from the standpoint of flavor and color development. For example, McIntosh at 30 F remained firmest but never developed the characteristic flavor and aroma. Baldwin developed a more characteristic flavor at low temperatures than did McIntosh and retained its marketable qualities longer. The rate at which ripening progressed following removal from cold storage also differed with varieties. McIntosh developed its highest flavor in common storage but became soft-ripe in 2 mo.

The treatment of fruit immediately following picking had a potent influence on storage behavior, e. g., McIntosh delayed 5 days before storing showed twice as much decrease in firmness 1 mo after harvest as did fruit stored immediately. As to effect of differential cultural and fertilizer treatments on keeping quality, Baldwin apples showed no significant response. Orchard site or type of soil appeared to have more effect on quality of Baldwins than did fertilizer treatments in the same orchard. Baldwins grown in a well drained loam on a ridge were superior in flavor and appearance to those produced on bottom land. Drought injury to McIntosh did not increase in storage. Apple fruitfly or railroadworm became inactive in apples stored at from 30 to 32 F and was killed 1 mo after storage, while in common storage the insect continued its normal development. Apple scab increased in size in storage but less rapidly at low temperatures. Cortland apples harvested with a tinge of yellow in the ground color showed very little scald in storage and kept more satisfactorily than fruit of earlier or later harvests.

SAVING VIRGINIA SOILS, *L. Carrier et al.* U. S. Dept. Agr., Soil Conserv. Serv., 1936, SCS-RB-4, pp. [2] + 23, pls. 5. Practical information is given on mechanical, agronomic, and other means of preventing the loss of Virginia soils by erosion.

OPEN TANK CREOSOTE TREATMENT OF SHORTLEAF AND LOBLOLLY PINE POLES, *E. J. Downey*. Jour. Forestry, 35 (1937), No. 4, pp. 349-352, figs. 2. A method of treatment is described in which poles, first heated in a vat at temperatures ranging from 220 to 225 F for 1 hr were transferred at once to a cool vat at approximately 100 F. After from 1 to 1.5 hr in the cool vat, penetration of about 1 in was obtained. Transferred again to the hot vat, the expansion of the creosote not only drove out part of the surplus but also pushed the creosote more deeply into the wood, reaching an average depth of 1.83 in. *(Continued on page 376)*



5 SIZES

OF PROVEN DIESEL TRACTORS ...25 TO 95 DRAWBAR HORSEPOWER!

The 3-4 plow Diesel D2 brings the number of "Caterpillar" Diesel Tractor sizes to five—ranging from 25 to 95 horsepower. Each of these five sizes has been developed with a distinctive working capacity; each is engineered to meet the needs of users who require its base-load pulling power. There are no "gaps" in the size range—and all sizes operate with characteristic "Caterpillar" Diesel Economy!

Thus, whatever pulling power a farmer requires, from 3-plow up to 12-plow, he can choose a size of "Caterpillar" Diesel Tractor that is engineered to do his work efficiently. "Caterpillar" is the only manufacturer that builds five sizes of Diesel tractors, *engines and all*, in its own plant!

Many "Caterpillar" Diesel Tractors have each done 15,000 hours of heavy-duty work, and are still going strong. Behind these tractors is unique proof of long working life, low up-keep and steady performance.

CATERPILLAR

REG. U.S. PAT. OFF.

TRACTOR CO., PEORIA, ILL.

DIESEL ENGINES

TRACK-TYPE TRACTORS • TERRACERS

Agricultural Engineering Digest

(Continued from page 372)

THE NICHOLS TERRACE: AN IMPROVED CHANNEL-TYPE TERRACE FOR THE SOUTHEAST, *J. J. Henry* in collab. with *M. L. Nichols*. U. S. Dept. Agr., Farmers' Bul. 1790 (1937), pp. II + 13, figs. 12. The Nichols terrace is described in this bulletin and is characterized as a major contribution to agriculture, being widely accepted in the Southeast as the most effective means of erosion control.

The Nichols terrace is not a terrace in the true sense of the word. It is instead a shallow waterway which conducts runoff water slowly from cultivated fields. The terrace feature is built entirely from the upper side so that soil is moved only down hill. A shallow, broad channel is cut down into the soil or often into the subsoil below the natural level of the field. This broad channel spreads the water and thereby reduces its power to carry away the soil, and overcomes the most serious objection to the hillside ditch. No effort is made to maintain the distinct terrace ridge, the ridge being blended into the slope after the field is worked. Information is given on the best methods of constructing the Nichols terrace.

THE PROBLEMS AND NEEDS OF SOIL CONSERVATION, *H. H. Bennett*. U. S. Dept. Agr., Soil Conserv. Serv., 1937, SCS-MP-18, pp. 13. This is an address on the subject presented at the Annual Conference of Extension Workers at Purdue University, October 7, 1937.

Literature Received

"FARM GAS ENGINES AND TRACTORS", *by Fred R. Jones*. Second edition, 485 pages, 6x9 inch, illustrated. The two parts of the first edition have been combined, duplication eliminated and new subject matter added on diesel engines, electric generators and starters, fuels and combustion, pneumatic tires for tractors, and economics of horse and tractor power. Changes have been made in material on fuel systems and carburetion, ignition and magnetos, lubrication and lubricating oils, tractor engine construction and transmissions. McGraw-Hill, $3.75.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL AND CHEMICAL ENGINEER, with nine years experience in agricultural engineering teaching and research and two years industrial experience, desires position in either teaching or research. Age 35. Married. PW-289

AGRICULTURAL ENGINEER, 1936 graduate, single, 25 years of age, southern, desires change. Has been in continuous employment since prior to graduation. Experienced in land survey, contour survey and mapping, drainage, dam planning and construction, sanitary and highway engineering and minor construction. PW-291

AGRICULTURAL ENGINEER, recent graduate, available and interested in any job for which he may qualify anywhere in North, Central, or South America. Some experience in construction and pavement of highways, and as clerk to the Secretary of Agriculture, Havana, Cuba. PW-292

ENGINEER AND HOME ECONOMIST with bachelor of science degrees in general science and in electrical engineering and master's degree in practical arts with major in household management is interested in a position in extension work in rural electrification, research or teaching in household engineering. Experienced in teaching, research, and field work. PW-293

AGRICULTURAL AND ELECTRICAL ENGINEER desires position as head of rural electrification department of utility or executive sales position with manufacturer of farm equipment. Has had several years experience in actual farm operation: five years' rural electrification work in promotion, load building, and sales. Qualified for work in several departments of utility or manufacturer wishing to develop the rural market for agricultural or electrical equipment. PW-294